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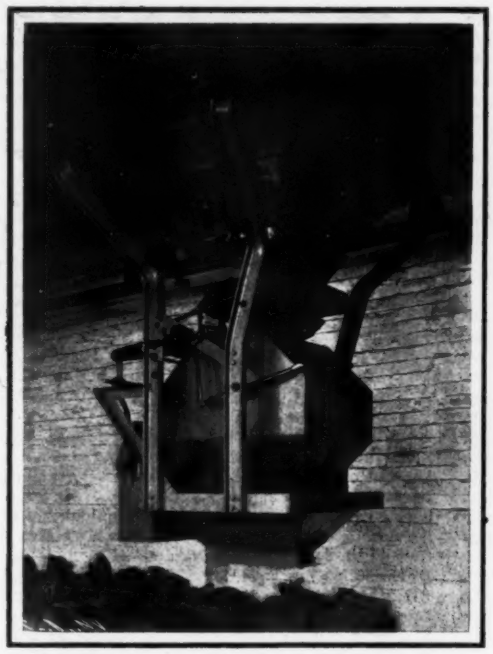
AUTOMATIC COAL WEIGHER FOR CHECKING FEED TO BOILERS.



OVERHEAD PORTABLE GRAIN WEIGHER AND FILLER.

AUTOMATIC PORTABLE WEIGHER IN OPERATION.

GRAIN SCALE WEIGHING GRAIN "OVER SIDE," CAPABLE OF HANDLING 150 TONS IN AN HOUR.

FOURTEEN AUTOMATIC COAL SCALES, CHECKING THE COAL CONSUMED BY THE BOILERS AT A TRAMWAY POWER STATION IN GLASGOW.

TYPICAL AUTOMATIC WEIGHING MACHINES.

TYPICAL AUTOMATIC WEIGHING MACHINES.*

By Emile Guarini.

A characteristic tendency of the present day is to substitute automatic work for manual labor, and this tendency is exhibited in the most complicated operations and in those in which human surveillance seems to be the most indispensable. A remarkable example of it is shown in automatic weighing, the application of which is daily becoming more and more common. The extension of automatic devices into this field is explained by the advantages that this mode of weighing presents, at least under certain circumstances, all of which may be summed up thus: Neatness, quickness, and accuracy of the operation, and saving in manual labor. Automatic weighing is applicable in a host of cases, such, for example, as in the grain industry, flour milling, coal bagging, boat unloading, the sugar, rice, coffee, and bean trades, and the cement industry, etc.

Many establishments have made a specialty of the construction of this kind of apparatus, but there are few that offer as varied and interesting types as does the firm of W. & T. Avery, of Birmingham, England, which is exploiting the Richardson-Avery patents. The Richardson-Avery automatic weighing apparatus may, according to the purpose for which they are designed, be grouped into three classes. The first of these comprises apparatus for the weighing of cereals, and these are the most numerous; the second embraces apparatus for the weighing of coal; and the third, apparatus for weighing various other articles, such as flour, cement, colonial products, etc.

In addition to these automatic apparatus, the firm is constructing some very interesting non-automatic ones, of which we shall have a few words to say after taking a cursory glance at the machines embraced in each of the three classes above mentioned.

The first of the apparatus of the first class is an automatic grain scales, especially designed for flour millers, grain dealers, brewers, distillers, etc. It possesses three very interesting characteristics, viz., an arrangement that affords a perfect equilibrium, whatever be the kind of weighing done; a long scale beam oscillating with entire freedom and independent of all the active parts of the machine, and consequently having a motion free from friction; a hopper and a closed weight-box entirely free from the guides which in other weighers are necessary for preventing the oscillations and vibrations of the hopper that occur when the machine is discharged, and that are caused by friction and a useless wear of the knife-edges, which makes the weighing inaccurate. The machine is constructed for weighing grain of the most dusty and unclean character, provided that it has been passed through a one-inch-mesh screen. It regulates itself automatically to the variation in the flow of the grain to the receiving hopper placed at the bottom of the machine. For this purpose it necessitates no special apparatus. This machine, which occupies relatively little space, and seems to be of remarkable accuracy, can in no case be arrested by a defect in the mechanism. Springs of a patented type prevent vibrations from occurring and causing useless wear.

To this type belongs the gross-weight machine for bagging grain—an apparatus specially designed for grain warehouses, granaries, malt houses, sugar refineries, etc. The machine is provided with the same parts as the one just described, and is supported by a light steel frame moving on rollers. It discharges the material directly into bags in the quantity desired, and is so arranged that the discharge regulates itself to the velocity with which the material is received in the bag and removed by the operator. Each discharge of the machine, and the exact number of bags filled, is thus known. The grain is weighed every time as soon as the inflow is arrested, and the operator can see that the desired weight is obtained. To the same type, too, belongs the net-weight machine for bagging grain. This machine is specially constructed for the use of those who prefer to obtain the net weight before putting the grain in bags. The speed of operation is from three to four bags a minute. The machine differs from the preceding only in its giving the net weight. Instead of being mounted upon a steel frame, it may be arranged in such a way as to move over a small aerial track, in which case it is completely suspended.

Another modification of the type described in the first place is the combined automatic and semi-automatic scales designed for the weighing of large quantities of grain for direct loading or unloading of vessels. It is so arranged that the accuracy of each weighing can be controlled and registered before the machine is discharged. It is possible to operate the machine from the interior of a building, where the accuracy of the work may be controlled. The charge cannot be removed until after a lever is moved by an inspector. There are about two hundred of these machines in use in the ports of Liverpool and London.

Of a somewhat different type is the automatic platform scales constructed especially for the grain docks of London. The 150 machines of this kind now in operation have given the most complete satisfaction. The weighing is entirely automatic. After the inspectors have ascertained that the beam is in equilibrium, a lever is manipulated, the machine automatically discharges its load, and another weighing begins. The machine is always practically accurate.

We shall finish the first class with a few words upon a weighing machine giving absolutely regular mixtures of from 20 to 100 per cent. This machine is constructed especially for millers and is designed to give an average mixture more accurately than rotary mixers. The machine is so constructed as to permit of the use of all weights from 20 to 100 pounds, and to facilitate the same changes in the mixture. With this object in view, the grain is discharged into a hopper combined with the scales. To this hopper is adapted a slide that permits of the manipulation desired.

The clouds of dust that usually accompany the handling of coal, as well as the irregularity of the lumps, have, up to the present, offered an insurmountable obstacle to the automatic weighing of this material. The Avery scales, therefore, are a distinct improvement in this respect, and so we place them in a special class. These automatic coal scales are naturally very extensively employed in coal yards, gas works, central electric stations, coke-washing establishments, etc. They are constructed after the pattern of the grain scales above described, but, in addition, are provided with a feed arrangement and a few special parts necessary for the handling of coal. Some of these machines are capable of weighing as many as 100 tons of coal an hour. One form of machine is designed to furnish coal to stokers automatically. It has a capacity of 100 pounds and is arranged solely for weighing fine coal. It is provided with suitable gearing, by means of which it can be stopped at will. Moreover, it can be set in operation only by a person in authority. It is provided with a counter that accurately registers the quantity of coal consumed. A separate machine is necessary for each boiler.

AUTOMATIC SUGAR AND RICE WEIGHERS.

In the third class we have, in the first place, scales for weighing flour. The construction of these is analogous to that of those of the first type described, except that here there is provided a Richardson feed arrangement which gives an equal and regular flow of material during the operation. Another form of this machine is designed for weighing flour in paper or cotton bags of a capacity of from 3½ to 14 pounds. It is claimed that this is the only machine made that does such work automatically. The operation is performed three or four times more quickly than by hand, while the work is done in a much better manner. These two last machines are evidently capable of being used for weighing other pulverulent substances, such as cement, sugar, etc. For this last named material, as well as for rice, grain, and other food products of the same nature, the firm is constructing, in addition, a type capable of weighing from 1 to 4 pounds with the use of standard weights as in an ordinary scales. With this apparatus 12 one-pound bags can be weighed per minute.

Among the non-automatic apparatus of the same firm may be mentioned its Roman balances, with hopper, of a capacity of from one ton to two tons, some of which are provided with registering apparatus and loading and unloading indicators. But we shall not dwell upon these apparatus, as they do not come exactly within the scope of this article, which is devoted, before all else, to the subject of automatic weighing machines.

We have, of course, been unable to give a detailed description of each of the machines mentioned; but the little that we have said will suffice, we think, to give an idea of the activity of the Avery establishment in this line of manufacture, and of the improvements that it has introduced into its machines.

STEELYARD HOPPER WEIGHER.

TYPICAL AUTOMATIC WEIGHING MACHINES.

* Specially prepared for the Scientific American Supplement.

ADVANTAGES OF GAS AND OIL ENGINES FOR MARINE PROPULSION.*

By John E. Thornycroft, Esq.

It has been recognized for some time by engineers who have to do with large power installations for land purposes that the reciprocating steam engine has been developed to a stage that cannot easily be improved upon, and that if greater economies are required they must look either to the steam turbine or the internal combustion engine.

Naval architects and marine engineers have been quick to take up the steam turbine; but, although the internal combustion engine has been developed to a

* Read at the Spring Meeting of the Forty-fifth Session, held in the Hall of the Society of Arts, London, March, 1904.

high degree of efficiency on land, it has, up to the present time, only been used to a limited extent for marine purposes, and then only for driving launches and small craft.

The advantages which oil and gas engines offer are so great that it is difficult to understand why they have not been more largely used. They necessitate the employment of some complications which steam engines avoid, but the one great advantage of their requiring neither boilers nor condensers will, it is thought, be found to more than compensate for these complications. Before making a direct comparison it will be well to consider the different systems, and the way in which they work.

CLASSES OF ENGINES.

Internal combustion engines may be divided into several classes, according to the fuel they employ:

I. In which the combustible employed will vaporize at atmospheric temperature.

II. In which the combustible requires vaporizing by heat or by spraying.

III. Gas engines, using gas from some form of producer using solid fuel.

Engines of the First Type.—The "Daimler" motor is representative of the first type, and practically all the engines working on the Otto cycle with this class of fuel are developments of Daimler's original engine, and are the simplest and lightest of the different types, as the fuel, in the form of petroleum spirit, is drawn into the cylinder with the amount of air necessary to burn it by the suction stroke of the engine. The apparatus for mixing the spirit with the air is of a very simple character, and the class of fuel permits of a high degree of compression being employed without danger of premature ignition; this high compression produces a high explosive pressure, and the cylinders of the engine are small in proportion to the power, and so the engine is light. Engines have been made by the German Daimler Company up to 200 B. H. P., by several American builders up to 150 B. H. P., and by Messrs. Vickers, Sons & Maxim up to 300 B. H. P. for British submarines.

Most of the leading motor car builders, both on the Continent and at home, have built engines of considerable power of this type, which have been fitted to launches. In America there are a number of firms building small types of engines which do not follow the Otto cycle, but give an impulse at every revolution, by using the under side of the piston and crank chamber for pumping the charge of explosive mixture into the cylinder. This type cannot be run at a high speed, and is not suitable for large powers.

Engines of the Second Type.—There is a much greater variety of engines coming under the second heading, as the difficult problem of vaporizing the fuel has been treated in a variety of ways by different builders.

The stationary oil engine has been made very perfect for work where there are no very rapid or great changes of load, but for marine purposes where a considerable amount of variation takes place in maneuvering, the problem becomes much more difficult. Most of the engines work on the well-known Otto cycle, and the variations occur in the different methods of introducing the fuel and vaporizing it. In the case of the Priestman and Griffin, two of the earliest, the fuel is sprayed by air pressure into a vaporizer heated by the exhaust products, and then taken into the cylinder on the suction stroke. In the Vosper and Roots engines, it is either pumped or measured into a vaporizer without being sprayed.

In the Hornsby, the oil is pumped directly into an extension of the cylinder, which is maintained at a high temperature, and the air is introduced separately. This method has the advantage of great simplicity, as no igniting device is required, as the heat of this chamber is sufficient to ignite the charge on compression, but it is only possible to work with a very low compression, to avoid premature ignition, and, therefore, the type of engine is necessarily a heavy one.

The Diesel engine, which has, as yet, been only used in one or two cases for marine purposes, is a most interesting type. It works on the four-stroke cycle, but sprays the oil into the cylinder by means of compressed air at the end of the compression stroke; the compression being so high (viz., about 500 pounds) that when the oil is sprayed it at once ignites, owing to the heat of the compression, which is about 1,000 degs. F. There is no actual explosion, as the fuel is introduced into an excess of air and burns as it is injected. A gradual and complete combustion of the fuel takes place, resulting in a very high economy. The power can be regulated to a great nicety, as the fuel is always burned at the same temperature, but in varying quantities. The engine is, however, necessarily a heavy one, to withstand the very high pressure, and the lightest type so far gives only about 10 H. P. per ton.

The Strickland engine is designed on the same principle of injecting the fuel at the end of the compression stroke, but does not compress to more than 200 pounds, and, therefore, has to use an igniting device. It is also arranged to work as a two-cycle engine, giving an impulse at every revolution, as some of the Diesel engines have done. It is fitted with a prolongation of the piston to form a pump to supply the air for the scavenging stroke, and the necessary air for combustion.

It would seem that an engine of this type, not working at too high a compression, so that it does not require to be so very strongly built, and giving two impulses for one of engines working on the Otto cycle, should have very great advantages, as a high mean pressure can be obtained without danger or premature ignition, and no vaporizers are required for the fuel; the vaporizers being always the part of the engine most difficult to design, and requiring the largest amount of attention.

Engines of the second type will always be more difficult to handle, in consequence of the vaporizing difficulties, than the first and third; but it is probable that because of the portability, safety, and comparative cheapness of the fuel, they will be used very extensively.

Engines of the Third Type.—The gas engine has hardly yet been tried for marine purposes; but, owing to the recent great improvements in gas producers, it is thought that they will soon be used extensively.

An engine designed for working with gas from solid fuel consists essentially of the same parts as engines of the first and second classes without the apparatus for vaporizing the oil or spirit, the gas producer taking the place of the vaporizer, but being necessarily much more cumbersome. But the gaseous fuel which is produced is essentially different to that produced by the vaporizer or carbureter of engines of the first two classes, as it is a stable gas, and can be stored if desired, and the vapor cannot; so that when maneuvering is taking place, and the vapor engine is being stopped and started, the producer is not entirely put out of action, as is the vaporizer, but to some extent can act as a fly-wheel and reserve of power, like a steam boiler.

The recent improvements, which have enabled the producer to be worked without the reservoir for the gas, the engine sucking the supply directly from the producer, make the apparatus much less bulky, and, therefore, better adapted for marine purposes.

The first type of engine is necessarily the lightest, as there is no vaporizer or producer, the fuel being vaporized by the simple expedient of sucking the right amount of fuel in with the air to the cylinder. Engines of this class are being made to weigh not more than 10 pounds or 12 pounds per B. H. P. Comparing this figure with that of the modern torpedo boats or destroyers, which is 50 pounds per I. H. P., it is evident that the naval architect has great possibilities with this type of engine. There is every prospect that engines of the second class will be built, including the vaporizer, for not more than 25 pounds per B. H. P. for moderate sizes. The engine of the third class should not be heavier, but, of course, there must be added the weight of the producer.

Starting and Reversing.—The smaller types of engines for launches are very easily handled, it being possible to start them up by a few turns of the engine; but, when the size gets too great to be man-handled, other means of starting have to be devised. In the large engines used in the submarines, the engine is used in conjunction with electro-motors and dynamos, so that the motor can be used for starting the engine.

In the case of the first and third classes, the starting is not very difficult, as the engine can be turned slowly with a suitable turning gear, and then, the cylinder being full of an explosive charge, they can be fired electrically at the right time, and the impulse is sufficient to carry the engine round for several revolutions, and set it in operation.

In the case of the second class this is not practicable, and it is necessary to have a reservoir of compressed air or gas of sufficient volume to give the engine several turns working as a pressure engine; this, of course, necessitates additional valves for the purpose. In smaller motors it is possible to reverse either by a reversing screw, or in some instances it is accomplished by stopping the engine, and by having suitable cams for operating the valves and starting the engine in the reverse direction by hand, but this has not been found very satisfactory, and the best practice seems to be to fit the engine with a suitable reversing gear and clutches for throwing it in and out of gear. It is, at present, unknown to what sizes these reversing gears can be successfully built, but recent improvements in clutches made by Prof. Hele-Shaw go to show that there should be no great mechanical difficulties in producing them up to several thousand horse-power.

The Bertheau engine has been specially designed with a view to making it very easily handled. Reservoirs are provided into which the engine compresses or delivers the burnt products of combustion at a high pressure; the compressed gases in this reservoir being used when required for starting up the engine, or giving it a few impulses in a reverse direction when it is required to go astern. The engine is provided with a double set of cams, either of which can be thrown into operation, and at the same time the engine is converted from a four-cycle to a two-cycle, to better enable it to maintain its speed when it is being driven by the compressed gases as a pressure engine. The author's firm are building engines of this type of considerable powers, and he thinks that probably, although the engine is complicated by these appliances, it will be found better in the larger sizes than any reversing gearing.

A comparison of the weights and space occupied by comparatively low-powered engines of the first class fitted to launches in the place of steam engines and boilers of the same power shows very greatly in their favor; but when petrol is used as fuel, it will be found more expensive than coal to do the same work. On the other hand, as the engines are practically automatic in action, and can be started at once (requiring no preparation like a steam boiler), an engine-driver can usually be dispensed with, and, as the steersman can do all the work of controlling the vessel, it will frequently be found cheaper to run with this class of engine than with steam.

While there is very little danger from fire with properly constructed engines, fitted with electrical ignition, and using spirit or oil of a low flash point in open boats, the risk must not be disregarded where they are fitted in a closed engine room below decks.

Capt. du Boulay has devised an arrangement by which only a small quantity of fuel is kept in the engine room in a small tank, any leakage draining directly overboard. The main supply is stored in a tank in a specially bulkheaded compartment, which also drains overboard; and in some cases the sea is allowed to flow into it and around the tank, thereby avoiding any possibility of the leakage of oil into the bilge of the vessel.

With engines of the second class, using oils having a flash point of above 75 deg. F., there is practically no danger from fire, and when the engine will work with less than 1 pound of oil per horse-power hour, the cost of working will, as a rule, be found less than that with the equivalent steam machinery; but, as yet, there has always been the disadvantage of an objectionable exhaust.

The Diesel engine costs only one-tenth penny per hour, as it works with unrefined oils, which can be bought for 2d. per gallon, and uses less than ½ pound of oil per horse-power hour. Only the most economical steam engines, supplied with coal at not more than 10s. per ton, can equal this performance.

It is well known that gas engines of even small powers, supplied with producer gas, give considerably more power per pound of fuel than could be obtained with a steam engine and boiler, and when large plants are used, a given quantity of fuel will produce four times the power obtainable with ordinary steam engines.

Gas producers must be divided into two classes—those which work with non-bituminous coal, and those which work with bituminous. The former class working as a suction producer is very simple, and weighs, as made for land purposes, considerably less than the ordinary type of steam boiler to do the same work; but, owing to its being restricted to one class of fuel, its use must be very limited for marine purposes.

The producer invented by Dr. Mond for using bituminous fuel has not yet been worked out suitably for marine purposes, and as used on land is heavier than boilers of the same power; but it seems probable that, owing to the much greater economy obtained and the rapid development which is going on, it will soon be possible to employ producers of this type.

EARLY RAILWAY TRACTION.

THE first attempt at steam traction on a railroad is thus recorded in the Bristol Journal for March 3, 1904:

"On Tuesday se'nnight one of Mr. Trevethick's steam engines was set to work on the colliery of Alexander Raby, Esq., at Lianelly, Carmarthenshire. On Tuesday last a trial was made of another of these engines at Merthyr Tydvil, Glamorganshire, for the purpose of ascertaining its powers in drawing and working carriages of all descriptions on various kinds of roads; and it was found to perform to admiration all that was expected from it. In the present instance the novel application of steam, by means of this truly valuable machine, was made use of to convey along the tramroad ten tons long weight of bar iron from Penydarron Iron Works to the place where it joins the Glamorganshire Canal, upward of nine miles distance; and it is necessary to observe, that the weight of the load was soon increased from 10 to 15 tons, by about 70 persons riding on the trams, who drawn thither (as well as many hundreds of others) by invincible curiosity, were eager to ride at the expense of this first display of the patentee's abilities in that country. To those who are not acquainted with the exact principle of this new engine, it may not be improper to observe, that it differs from all others brought before the public, by disclaiming the use of condensing water, and discharges its steam into the open air, or applies it to the heating of fluids, as conveniently may require. The expense of making engines on this principle does not exceed one-half of any on the most approved plan made use of before this appeared; it takes much less coal to work it, and it is only necessary to supply a small quantity of water for the purpose of creating the steam, which is a most essential matter. It performed the journey without feeding the boiler or using any water, and will travel with ease at the rate of five miles an hour. The gentleman under whose patronage the above valuable improvement has attained its present perfection is S. Homfray, Esq., of Penydarron, near Merthyr Tydvil."

Trevethick's "Perfection" of five miles an hour was the modest forerunner of our present express engines of 60 to 85 miles an hour.

Correspondence.

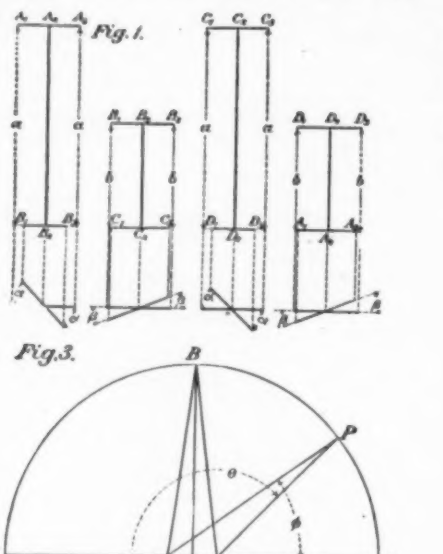
AN INTERESTING THERMAL FORMULA.

To the Editor of the SCIENTIFIC AMERICAN:

After much work on heat losses at high temperatures by direct radiation + air convection, I have found the following formula (which is vastly different from anything suggested heretofore) to truly define the emissivity curve from various experiments up to 1,000 deg. Cent. As it may be of use to engineers, I have selected your valuable SUPPLEMENT to publish it if agreeable to you.

Taking T_1 as the temperature of the hot body in degrees Centigrade absolute scale, and T_2 the temperature of surrounding air (same scale), the therms or gramme degree Centigrade calories lost from each square centimeter per second is given by 0.0000036

$(T_1-T_2)^{\frac{7}{4}}$ $(T_1/T_1-T_2)^{\frac{1}{2}}$ when the body is iron or steel when flat, or if the radius of curvature exceeds one centimeter; also 0.00001328 $(T_1-T_2)^{\frac{7}{4}}$ $(T_1/T_1-T_2)^{\frac{1}{2}}$ gives British thermal units per foot square per second. Taking iron or steel as unity other numerical coefficients for, say, fire brick, etc., easily suggest themselves. Expressed in words a numerical constant differing for various substances and the magnitude of the thermal unit employed is first multiplied by the fourth root of the seventh power of its temperature above the air expressed in degrees



PRINCIPLE OF THE FOUR-PIECE MECHANISM.

Centigrade and this product is then multiplied by the square root of the quotient obtained by dividing the temperature of the body on absolute Centigrade scale by its temperature above the surroundings.

Various curves plotted from the experimental results of Forbes, Petavel, Dulong and Petit, and others fall closely in the paths defined by the above much-needed equation. EDWARD C. BROADWELL, Chemist.
4429 State Street, Chicago, Ill.

A NOVEL FOUR-PIECE MECHANISM.*

By the English Correspondent of the SCIENTIFIC AMERICAN.

A NEW four-piece mechanism possessing some novel features has been designed by Mr. G. T. Bennett, M.A., of Emmanuel College, Cambridge, England. It is quite distinctive from the two familiar types of mechanisms of this description composed of turning pairs. The one type is known as the "cylindric" and the other the "spheric." In the former the axes of rotation are all parallel to one another, while in the latter the axes all converge in a point. If the axes are disposed differently from either of these two types a chain of four pieces is produced, and as it is absolutely stiff, consequently no mechanism is produced.

In the new apparatus, however, the designer conclusively demonstrates that there is an exception to this commonly believed precept, and it has apparently escaped the notice of any other experimenters in this direction. In his arrangement a skew mechanism is produced wherein the axes of rotation are neither parallel nor concurrent, and the arrangement offers the simple means of communicating rotation immediately between two crossing shafts by the use of one connecting rod.

The essential geometrical features of any one of the links composing a skew mechanism of turning pairs are: (1) The angle of inclination of the axes of rotation by which the body is connected with its two neighbors; (2) the length of the shortest distance or common perpendicular between those axes. In the new mechanism the four links satisfy the following conditions: (1) Two alternate links have the same length and the same twist or angle; (2) the other two alternate links have the same length and the same twist.

In assembling the link work, the terminals of the central axes are made to coincide so that they make a skew quadrilateral with equal alternate sides. The purely geometrical form of the four links and the method of putting them together are shown in Fig. 1.

The movement of the mechanism is as follows: When any one of the four links is fixed—this is then regarded as the frame or bed of the mechanism—and an adjacent link caused to revolve about its fixed axis of rotation as a driver crank, the motion is communicated to the fourth link through the third link, which acts as a connecting rod. The fourth link revolves thereby as a driven crank turning about its fixed axis of rotation.

In varieties of geometrical form, the angles a and B and the lengths a, b, by which the mechanism is geometrically specified, are only subject to one restriction, that of the equation $\frac{\sin a}{a} = \frac{\sin B}{b}$, so that all but one of the four quantities may in the majority of cases be assigned at will. But, on the other hand, if a and b are assigned, a being the greater, then B cannot be taken larger than $\sin 1 \frac{b}{a}$, to which will correspond a unique value of a equal to 90 deg. Any smaller value of B allows either of two supplementary values to be given to a. If a and B have values approaching zero, the link-work approximates to the ordinary plane parallelogram link work; and if B approaches zero and a approaches 180 deg., the link work approximates to the ordinary plane "crossed parallelogram" form.

These two special plane forms appear thus as extreme cases of the skew link work. The intermediate case in which the twist or angle a of the longer link a is equal to a right angle may be regarded as a separating case lying between those skew forms (with a less than 90 deg.) which approximate more nearly to the parallelogram form on the one hand, and those which (with a greater than 90 deg.) more resemble the crossed parallelogram form.

Concerning the three possible "inversions" of any form of the mechanism, it will be realized that one is identical with the original, and that the other two give exactly the same movement again, but with interchange of the lengths a, b, and of the angles a, B.

Another very special form occurs when a an[d] ... taken equal, and a and B supplementary to each o[ther]. The representative ellipse then degenerates int[o a] straight line. Each crank in turn revolves thro[ugh] four right angles, while the other remains at rest, [the] connecting rod moving as one piece with each cra[nk] alternately. It may be regarded as a skew form [of] the "two-ways hinge" of plane or spheric mechanis[ms].

For the two degenerate plane forms of the mech[an]ism the zero positions, in which the central axes fall [in] one straight line, are simultaneously "dead cente[rs]" and "change points;" the former because the thrust [or] pull—the only possible stress—in the connecting [rod] produces no turning moment about the fixed axis [of] rotation of the driven crank; and in the latter beca[use] on passing the zero position either form can be c[on]verted into the other. On the other hand, with rega[rd] to the skew mechanism the zero positions are neit[her] dead centers nor change points. The mechanism [has] only one mode of movement which is possible in th[e] positions, as in all others, and a turning moment

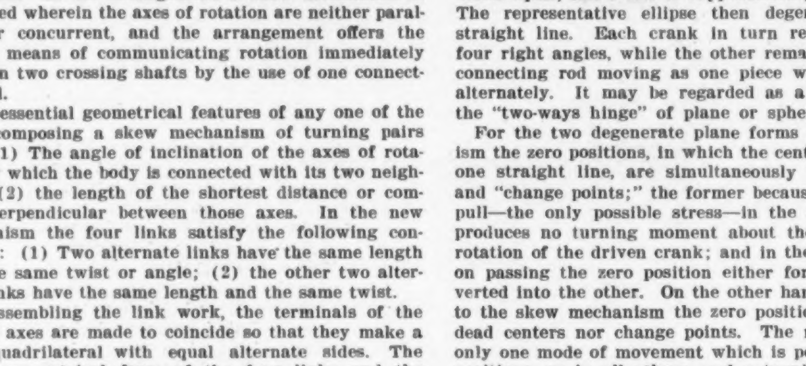


FIG. 2.—FOUR-PIECE MECHANISM SHOWING ARRANGEMENT OF SHAFTS.

the driving crank produces a similar effect to [the] driven crank. So far as thrust or pull is concern[ed] the stress on the connecting rod transmitting the d[riv]ing motion is inoperative and is similarly the case [in] connection with twist round its central axis. [The] other component stresses, however, which affect [the] connecting rod—comprising two wrenches at its e[nds] perpendicular to the central axis and the respec[tive] hinge lines—are more effective in the zero positi[on] than in any other.

The material form given to the links is a matte[r of] individual choice and design, and the practical sh[ape] given to the design varies with the purpose of [the] mechanism.

In our first illustration the material coincides v[ery] closely with the lines of the skeleton, and the re[sult] is that although the geometrical features of the [ma]chines are clearly demonstrated, the links interf[ere] with one another at some time or another, thus yi[eld]ing only a limited range of movement. But in the other illustrations the frame and cranks are desig[ned] in such a manner that continuous freedom of m[ove]ment is allowed, though it will be realized on ex[am]ination that the geometric form is somewhat disgui[sed]. In the model shown in these illustrations the sh[afts] are made at right angles to one another, the one be[ing] vertical and the other perpendicular. The cranks [in] this instance are 2 inches in length, and are hinged [to] the connecting rod about hinge lines, thus making [an] angle 15 deg. with the respective shafts. The conn[ect]ing rod is of the same length as the distance betw[een] the shafts—7.73 inches—and the hinge lines are [per]pendicular to one another at its ends. Fig. 2 [is a] broadside view, and Fig. 3 a view nearly endw[ise] taken at a different point of the movement.

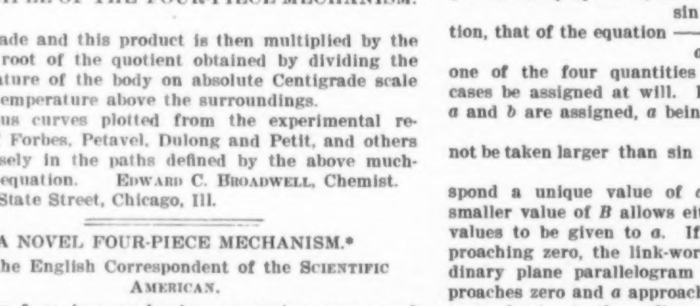


FIG. 1.—ACTUAL MODEL MADE TO EXHIBIT COMPLETED LINK WORK.

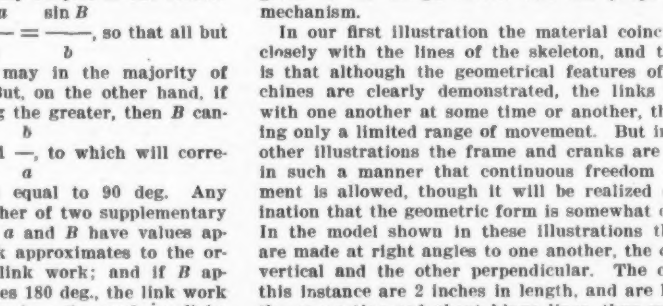


FIG. 3.—MODEL WITH SHAFTS AT RIGHT ANGLES TO EACH OTHER.

There is one point in the first illustration w[hich] demands certain explanation. Near one end of [each] link it will be noticed that there is a nut and [co...] In this particular model each link is made in [two] parts, consisting of a wire carrying the hinge at [one] end moving in a sleeve carrying the hinge at the o[ther], and the two parts being clamped together by tigh[ten]ing the screw. This enables the model to be so [set] as to show different values in turn for the len[gths]

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

...sists of the links. But it must not be imagined this temporary movement is in any way neces-... to the operation of the skew mechanism. It is ...ply provided for the convenience of demonstration ...the principles of the invention.

...E TELEFUNKEN ONDOMETER FOR THE MEASUREMENT OF WIRELESS TELEGRAPHY WAVES.

By Our Brussels Correspondent.

The greater the progress that is made by wireless ...egraphy, and the more numerous that its applica-...ns become, the more the necessity of preventing the ...erference of dispatches is felt. In order to give an ...a of the very large number of radio-telegraphic sta-...ns installed in the different parts of the world, we ...ll recall the fact that the Gesellschaft für Drahtlose ...egraphie of Berlin, which is exploiting the tele-...ken system, that is to say, the Slaby-Arco and ...aun systems, had 250 stations in operation in the ...nth of January, 1904, while 69 others were in course ...construction.

...he opinion has sometimes been held that the best ...ng to do in order to prevent interference would be ...direct the waves toward a determinate point, as is ...ne in optical telegraphy. In other words, it would ...necessary to return to the path pursued by Hertz ...th his reflectors, and employ arrangements such as ...make it possible to bring into play the large quanti-...s of energy necessary for reaching great distances. ...uld that be possible with the use of the antenna and ...ground-plate? This it would be difficult to admit, ...as many are inclined to believe and experiments ...d us to suppose, the transmission takes place ...rough the conduction of the earth and atmosphere. ...can, in fact, "limit" the radiation but not the con-...tion.

...ending the definite settlement, experimentally, of ...s question so important for the future of wireless ...egraphy, most experimenters, for the purpose of ...aining secrecy in the dispatches, have adopted the ...nciple of syntonization. The problem, as we know, ...sists in electrically attuning the transmitting and ...eiving stations in such a way that the latter shall ...pond only to waves of very determinate period ...itted by the former. In order to effect this, it is ...essary to know the wave length of the transmitter ...d receiver respectively. The electric constants of ... circuits may be so calculated that the wave length ...ll be known in advance. Nevertheless, the factors ...ich vary with the places and circumstances are so ...merous that it is generally through experiment that ...said wave length is determined.

...he telefunken ondometer is an apparatus for ...dily measuring these wave lengths. It is a closed ...cuit instrument, which was invented by MM. ...nke and Donitz, and which is manufactured by ...Société Siemens-Braun. It differs from the first ...m of ondometer, which was merely a resonance ..., in that in the "metrocoil," as this was called, the ...ering into resonance was determined by the ob-...vation of the highest tension (measurement of the ...rk), while in the present instrument it is recog-...ed by the observation of the amount of current by ...ans of a hot wire amperemeter.

The apparatus comprises a closed oscillatory circuit composed of a self-induction coil and a condenser. There is, in addition, an air thermometer, the bulb of which is heated by a wire, *w*, offering a high resistance. The condenser, *C*, which is situated in the center of the apparatus, is regulatable. In order to well insulate the plates and elevate the dielectric factor as well as its capacity, the condenser is immersed in a bath of paraffine oil. It comprises two series of

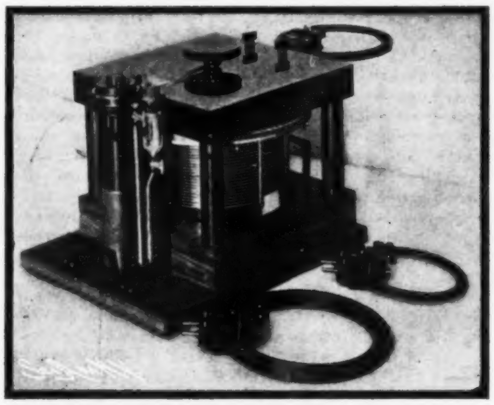


FIG. 1.—GENERAL VIEW OF THE ONDOMETER AND INDUCTANCE COILS.

semi-circular metallic plates, which are parallel and equidistant. One series, *f*, is stationary, while the other, *b*, is movable around an axis. On turning the latter, the movable plates become interposed between the stationary ones. The capacity of the system increases in proportion with this movement. Over the stationary plates of the condenser is a sector-shaped scale provided with graduations. If the pointer, *z*, is placed upon the 160 mark, for example, a capacity four times greater than when it is on the 40 mark is obtained.

The secondary transformer winding, *i*, may be modified by adding any one of three inductance coils to the circuit. Their ratios of self-induction are as ¼, 1, 4. There is a special scale for each coil, upon which may be directly read the wave lengths of the oscillatory circuit observed, which lengths may be from 140 to 1,120 meters.

In order to make a measurement, the ondometer is so placed in the vicinity of the oscillatory system that the surgings of the oscillatory circuit to be examined shall pass through the primary transformer winding of the ondometer and energize it. The proper inductance coils having been selected, the capacity is made to vary until the hot-air thermometer indicates a maximum. It will then be possible to read immediately, opposite the pointer, the wave length sought. The condition of the wave and its damping are ascertained by observing whether the current rapidly or slowly diminishes when the pointer is moved to the right or left from the place of resonance.

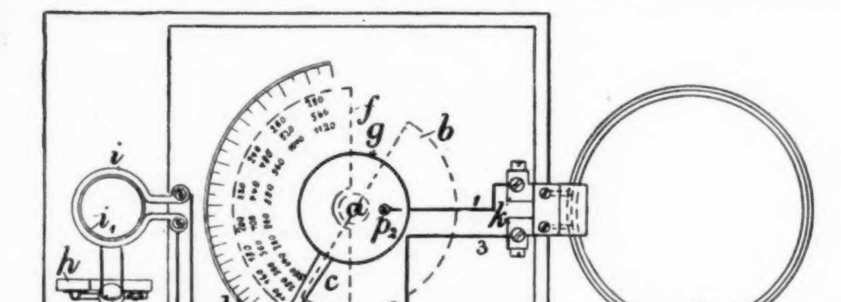


FIG. 2.—PLAN VIEW OF ONDOMETER.

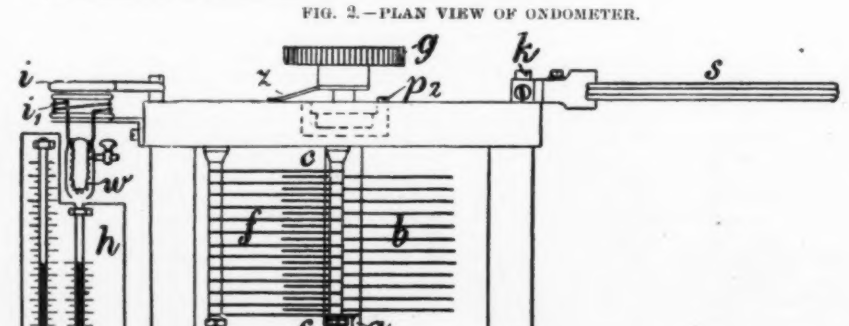


FIG. 3.—SIDE VIEW OF ONDOMETER.

THE TELEFUNKEN ONDOMETER.

The apparatus permits of examining open or closed systems indifferently. It is, besides, provided with three other coils of windings to be introduced into the resonance coils already mentioned, in order to make possible the measurement of the number of normal oscillations of a simple antenna. These coils, which comprise a couple of layers of wire, are placed in series with the antenna without perceptibly disturbing its inductance. The current from the antenna traverses them, and they excite the ondometer. The precision, even when the apparatus is manipulated by persons with little experience, is from 1 to 1½ per cent. It is therefore nearly equal to that afforded by the best laboratory methods.

TWO EARLY AMERICAN LETTERS ON ELECTRICITY.

The New York Nation prints the following interesting information:

To the Editor of The Nation:

Sir: The approaching bicentennial celebration of the birth of Benjamin Franklin renews our interest in one of the greatest names in the history of electricity —a science which, in its practical applications, America has made peculiarly her own, and in which one of her sons made an experiment that carried his name and that of the place of his birth around the world. Franklin's kite experiment, by which he established the identity of the lightning in the sky with the electric spark, is thought, perhaps by most persons, to be his most important contribution to the subject of electricity; but this is far from the truth. Even at this day his numerous experiments with Leyden jars, with electric shocks, with relations between electricity and heat, his theories of electricity and magnetism, are well worth considering. In these researches we perceive a great mind at work endeavoring to penetrate the mysteries of a subject which continues, even after the lapse of two centuries, to baffle the greatest intellects. I was present at a dinner lately where a distinguished English scientist expressed the opinion that we could still learn much from Franklin; he found the latter's experiments most suggestive, and he remarked that we seemed to be returning to a theory of electricity which resembled in many respects the one-fluid theory of Franklin.

Among the historical manuscripts in the Library of Harvard University are two which are of great interest to the student of electricity. One is a letter from Benjamin Franklin to Prof. John Winthrop; and the other is from Prof. Winthrop's notebook of the lectures he delivered on natural philosophy between 1738 and 1780. Franklin's letter is written in a beautiful hand, which I should be tempted to characterize as feminine if beautiful feminine handwriting were not converted, at present, into the Virginia-fence style. The letter runs as follows:

Phila, July 20, 1764.

"Sir I received your Favour of the 12th past, and congratulate you on the Recovery of Mrs. Winthrop and your Children from the Small Pox.

Mr. Stiles return'd Apinus to me sometime since.—I must confess I am pleas'd with his Theory of Magnetism.—Perhaps I receive it the more readily on Acct. of the Relation he has given it to mine of Electricity. —But there is one Difficulty I cannot solve by it, quite to my Satisfaction, which is that if a Steel Ring be made magnetical by passing Magnets properly round it, and afterwards broken into two Semi-circles, each of them will have strong N. & S. Poles, in whatever Part the Ring is broken. I have not try'd this, but am afraid 'tis so; & I know that a magnetic Bar broken has after Breaking 4 Poles i. e. becomes two compleat Bars.—I think with him that Impermeability to the El. Fluid is the property of all El., per se; or that, if they permit it to pass at all, it is with Difficulty, greater or less in different El.' per se. Glass hot permits it to pass freely, and in the different degrees between hot and cold may permit it to pass more or less freely.

"I shall think of the Affair of your unfortunate College, and try if I can be of any Service in procuring some Assistance towards restoring your Library. Please to present my Respects and Compliments to Dr. Channing, Mr. Elliot and Mr. Cooper and believe me with sincere Esteem

"Sir

"Your most obedient humble Servant

"B. Franklin.

"My Respects to the President, & to Mr. Danforth."

This reference to the impossibility of preventing the formation of two opposite poles in a piece of magnetized steel, however the piece is broken, is interesting from two points of view; it shows how the early investigators were hampered in trying the simplest experiments from lack of the varied mechanical facilities of the present day; and it shows that, with all our practical knowledge of magnetism, we are as ignorant of the cause of polarity in a piece of steel as Benjamin Franklin was. The distinguished Englishman I have referred to thought that the prevailing theory of electrons should lead us to reconsider Franklin's one-fluid theory of electricity, for Franklin explained the attraction or repulsion of two pith balls by the diminution or excess of his one fluid. The electron or corpuscular theory of the present explains the same phenomena by the detachment or aggregation of the electrified negative particles. Whether we fix our mind on a fluid or a collection of electrified particles, we can arrive at a plausible explanation of electrical attraction or repulsion.

The lecture notebook of Winthrop contains one lec-

ture on electricity delivered in 1764, probably the first on this subject given in an American college. John Winthrop was the only professor of natural philosophy in the American colonies, holding that chair in Harvard College between 1738 and 1780. The notes are as follows:

"Electricity is a property of some bodies wh. allternally Attracts and Repels all Light Bodies at a Sensible Distance, and is so called from electric amber, which is a property peculiar to that Body. Some sorts of Bodies, as all Glass, all precious Stones, and Sulphurs and all Dry animall Substances, have this property and are called Electricks, and all Bodies that have not this Quality are called Non-Electricks, such as water, wood, metals, etc. Electricity is excited in Bodies by Attraction; a Tube of ¾ of an Inch Diameter and two or three foot Long being rubed, will Attract or Repel Light Bodies such as Leaf Gold, soot, paper, etc. But non Electricks may become Electrical, by resting on an Electrical, and touching a non Electrical wh. Touches the excited Electrick. If a flaxen string (wh. is not Electrick) be extended and supported and at one end an excited Tube be apply'd Light bodies will be attracted and That at the Distance of 1200 feet at the Other End; this Electricity since the year 1743 has made a Considerable noise in the World; upon wh. it's suppos'd Several of the (at presant hidden) Phænomina of Nature Depend; it has been Carry'd to so Great perfection that an Electriz'd man by touching heated Spirits of wine he has set them on flame; If a man stand on pitch or Glass and hold a non Electrick in his hand, wh. touches a Glass Globe that is whirl'd with prodigious Velocity, be touch'd in any part of his body, There immediately succeeds a Considerable flame with a sensible pain and a Crackling Noise.—Men have been so Electriz'd; as to have a Considerable Light round their heads, and Bodies, not unlike The Light Represented Round the heads of Saints by the painters."

This lecture, it is seen, contains an intimation of the possibility of conveying signals by electricity.

In Franklin's time the popular interest in electricity was divided between the subject of lightning rods and the possibility of curing diseases by the remarkable and mysterious manifestations of energy. Now that the transmission of power and of intelligence by electricity has reached a high degree of perfection, we begin to see a reversion of interest to its possible curative powers. Electro-therapeutics is an important branch of medicine even if we are somewhat skeptical as to the direct effect of electricity upon the human organism, and regard the results as largely due to suggestion. This skepticism was shared by Franklin, who, in speaking of the large numbers who came to him to be healed, says: "Exercise in the patient's journey and coming daily to my house, or from the spirits given by the hope of success enabling them to exert more strength in their limbs, may be the cause of the improvement occasionally noticed."

The bicentennial celebration of Franklin's birth will doubtless give due prominence to his anticipation of the modern electron theory of electricity.

JOHN TROWBRIDGE.

Cambridge, Mass., April 16, 1904.

[Concluded from SUPPLEMENT No. 1485, page 23796.]

THE INFLUENCE OF PASTEUR ON MEDICAL SCIENCE.*

By C. A. HERTER, M.D., of New York.

VERY closely associated with Pasteur's work on anthrax is the admirable research in which the master, aided by Joubert and Chamberland, discovered the organism known to us as the bacillus of malignant edema but described by its detectors as the *Vibrio septique* in the same year (1877) in which the widely known publication on anthrax appeared. Of the many excellent features for which this research is distinguished there are two that deserve especial mention. First, the recognition of the *Vibrio septique* in the blood of animals not newly dead of anthrax was an extremely important service in clearing up the gravest objections to Davaine's doctrine of the etiology of anthrax. Secondly, the observation that the septic vibrio is anaerobic affords the earliest example of a pathogenic organism which in its vegetative form is inhibited by the presence of oxygen—a discovery which we may reasonably attribute to the experience gained sixteen years before with the butyric ferment.

In looking for fresh proofs of the bacterial origin of disease Pasteur made some visits to the hospitals of Paris and thus came into closer relations with the practitioners of medicine and surgery. The alert and intellectually honest minds bade him welcome and gave him every help to pursue his studies; the conservatives looked at him askance, confidently set up their time-worn theories against his experimental proofs and lost no occasion to ridicule the germ theory of the origin of disease. To-day it is difficult for us to picture the incredulity and amazement of many prosperous and self-satisfied practitioners on hearing Pasteur's announcement that he had found the same pus-exciting micro-organisms (probably the *Staphylococcus pyogenes aureus*) in the pus from a series of boils and in the pus from osteomyelitis, and that these conditions, so different in clinical characters, are identical as regards etiology. Very soon a second bomb of the same nature fell into the conservative camp with the confident and even fervid declaration that childbed fever is a septicemia commonly due to a coccus (streptococcus)* which could be detected in the cavity of the uterus, in the blood of the uterine sinuses, and in the blood of living patients. The far-reaching practical results of this investigation, to which Pasteur devoted only one short publication, are so well known to you that they call for no comment here.

Not long after the beginning of the anthrax study the attention of Pasteur was directed to a disease which was destined to play a remarkable part in leading to the great goal toward which the researches of the master were carrying him—the discovery that it is possible experimentally to induce immunity to disease caused by virulent micro-organisms. Perroncito, of Turin, and Toussaint, of Toulouse, had reached the conclusion that an organism detected by the former is the cause of chicken cholera, but neither had the requisite bacteriological training actually to establish the correctness of this contention. Pasteur was consulted on the subject, and, bringing to bear his superior knowledge and technical skill, succeeded in growing the organism outside the animal body and in experimentally inducing chicken cholera by means of these cultures grown *in vitro*. Returning to the laboratory after a short absence he found that his cultures of the bacilli of chicken cholera had failed to grow or had grown only feebly. To increase the activity of these micro-organisms they were now inoculated into normal fowls—a procedure suggested by previous experiments with other bacteria. The results were disappointing, for the inoculated animals showed no signs of the disease. This made it necessary to isolate and grow actively pathogenic bacteria from animals with chicken cholera. Having done this it occurred to Pasteur that it would be of interest to inoculate with fresh and virulent bacilli the animals already treated with the attenuated strain of chicken cholera organisms. This was done without delay, and, to his surprise, nearly all of these prepared animals resisted the virulent germs. They had been immunized by means of the attenuated cultures and a new principle had come into medicine. By experimental study and long reflection on the work of Jenner, the mind of Pasteur had been prepared to grasp the immense practical significance of this discovery. It appeared probable that what had been accomplished for chicken cholera could be extended to other diseases. One special consideration made Pasteur feel hopeful as to the possibility of immunizing sheep and cattle against anthrax. He had noticed that certain sheep long exposed to anthrax through grazing on infected pastures did not die after experimental inoculation with a virulent anthrax culture, whereas previously unexposed animals of the same herd died promptly after such inoculation. Moreover, he knew from experience that fowls can be immunized against chicken cholera by feeding them the specific germs of that disease, and this fact strongly suggested a similar explanation for the anthrax immunity which he had noticed. With that analogy in mind Pasteur took the first step toward the preparation of a vaccine against anthrax. As in the case of chicken cholera, he strove to attenuate the specific organisms of the disease. This he tried to do in the way that had succeeded so well in the case of chicken cholera, that is by exposing anthrax cultures to an abundance of oxygen at the body temperatures. But Pasteur found that under these conditions the anthrax organisms retain their virulence, owing, he believed, to their capacity to produce resistant spores. To check this growth of the anthrax spores he successfully resorted to the procedure of growing his cultures at temperatures of 42 deg. to 43 deg. C. in the presence of oxygen. By varying the procedure somewhat he was able to prepare a series of anthrax vaccines of different degrees of activity, the use of a mild vaccine being followed by that of a stronger one in the course of immunization.

The announcement by Pasteur, Chamberland and Roux of a method of protecting animals against the anthrax scourge excited great public interest but was in many quarters received with skepticism and derision. Pasteur was invited to make a large scale public test of his claims near Melun at the farm of Pouilly le Port. He accepted the challenge gladly and on May 5, 1881, began a series of public inoculations which will always be memorable in the annals of medical science. The publicity with which the unique experiment was performed; the unconcealed hostility and suspicion of many of the onlookers, and the alternating hopes and fears of Pasteur, have been most entertainingly described by M. Vallery-Radot. The outcome was a convincing demonstration of the practicability of Pasteur's method of immunizing against anthrax in sheep. Nevertheless, two years later, in an ill-natured attack on Pasteur's work, Koch attributed the discovery of vaccination against anthrax to Toussaint and pointed to a paper in which the latter had reported some experiments describing the immunization of dogs and sheep by means of anthrax bacilli which had been heated at 55 deg. C. for ten minutes.

While it is true that Toussaint thus immunized animals against virulent anthrax organisms, his method of obtaining a vaccine was unreliable and unsuited for practical use. The fact is that Toussaint, stimulated by Pasteur's discovery of a method for immunizing against chicken cholera, prepared a vaccine which somtimes protected against the disease but which was dangerous owing to uncertainty as to the number and condition of the living anthrax organisms which it contained. His publication appeared six months after that of Pasteur, who, although greatly interested in the observation of Toussaint, criticised the methods of the latter and ultimately prepared a safe vaccine consisting of definitely attenuated anthrax organisms. The crude experiments of Toussaint were wholly based on the epoch-making immunization to chicken cholera originated by Pasteur.

On March 15, 1882, Louis Thuillier, the earnest and gifted but ill-fated young assistant of Pasteur, discovered in the blood of swine dead of erysipelas (rouget de porc) an organism which appeared to be the active agent of this plague—an organism which Klein in his elaborate investigation had quite overlooked, but which was independently discovered by Detmers, of Chicago. Pasteur had inspired this fine research of Thuillier and stood ready to develop it. By carrying the suspected organism through many generations on veal bouillon and finally introducing it into hogs, the true swine erysipelas was readily induced. The real problem, however, was to make an attenuated virus for the purpose of immunizing against the disease. Pasteur succeeded in obtaining a virus capable of protecting certain races of hogs for a period of a year or more and this important practical success is rendered especially noteworthy by the method that was followed in attenuating the rouget organisms. In 1887 he had found in the saliva of rabid dogs an organism highly virulent for rabbits (micrococcus of rabbit septicemia).* Adult guinea-pigs were immune, but young guinea-pigs quickly died after inoculation. By passing the organism through a series of young guinea-pigs it gained in virulence until it grew fatal for adult guinea-pigs. But the modification which especially impressed Pasteur was that the bacteria which had thus gained in pathogenic qualities for guinea-pigs had at the same time become attenuated for rabbits.

The memory of this singular observation now came to his aid in the rouget research. After passing the rouget bacteria through a series of pigeons (which are naturally susceptible) it was found that the blood from the last pigeon had become much more pathogenic for swine than blood from hogs dead of swine erysipelas. On the other hand, Pasteur discovered that while the passage of the rouget organisms through a series of rabbits (which are not naturally susceptible) permitted these bacteria to grow more readily in the blood of rabbits and to become more highly pathogenic for them, they became definitely and permanently diminished in virulence for swine. Thus after inoculation with modified organisms hogs became ill but did not die. On their recovery they were immune to fatal rouget. The genius of Pasteur thus gave to biological science a definite method of permanently modifying the pathogenic characters of certain micro-organisms. This contribution is recorded in a paper which won the applause of the Academy of Medicine and which even to-day excites admiration for its mingling of experimental skill and scientific imagination.

So far back as 1880, in the midst of the exacting anthrax investigation, Pasteur had found time to begin a new research on the protective action of attenuated virus. From modest beginnings this research grew in the hands of the master to be the crowning work of his life, in the sense of embodying the fullest and in some respects most original expressions of his ideas on the uses of experimentally enfeebled viruses for the mitigation of infectious processes. The transmission of rabies through bites made probable the infectious nature of the disease and encouraged a hope that it would not be very difficult to isolate the specific organism from the saliva of rabid dogs. But the most systematic efforts to isolate such an agent were rewarded only by failure. To this disappointment was added a second, even more disconcerting. It was found that the experimental transmission of the disease by means of saliva is a matter of great uncertainty. Moreover, the uniformly fatal outcome of hydrophobia made it impossible to form any opinion as to whether the unknown virus was capable of conferring immunity. Many an investigator would have been deterred from the prosecution of an enterprise so unpromising, but the interest of Pasteur had been fully enlisted before he realized the difficulties of the problem, and the tenacity of his nature urged him to keep patiently on his course. He saw clearly that a reliable way must be found to communicate rabies experimentally, and acting on a suggestion made by Dr. Dubu, of Pau, that the disease is essentially one of the central nervous system, Pasteur took small bits of nervous tissue from animals dead of rabies and placed them under the skin of experimental animals. This method was no considerable improvement on similar inoculations of saliva from rabid dogs, but it served as the clew to a notable advance. This was the introduction of rabid nerve-tissue directly into the central nervous system of the animal to be infected, a procedure based on the idea that since rabies behaves like a disease of the nervous system the micro-organisms causing it would be likely to find in the nervous system a living culture medium highly favorable to their growth. The acute intelligence of the masterful experimentalist is strikingly illustrated by the fact that failure to isolate specific micro-organisms had not shaken his faith in the trustworthiness of his preconceived idea. Hence when he found that hydrophobia regularly followed subdural inoculation with rabic nervous material he was more pleased than surprised. The first dog thus inoculated showed unmistakable signs of rabies after fourteen days and other animals gave similar results. Moreover, on bringing into practice the experience he had gained in study-

* Address delivered at the opening of the Johns Hopkins Medical School, 1903.

* Pasteur's description of the organism found in puerperal septicemia is not full enough to make it certain that he was dealing with pure cultures of the Streptococcus pyogenes.

* Micrococcus lanceolatus.

ing swine erysipelas, Pasteur found that he could increase the pathogenic properties of the virus by carrying it subdurally through a series of rabbits or reduce it for dogs by carrying it subdurally through a series of monkeys. He thus had at his command three different viruses, a virus of natural strength, a virus of increased virulence and an attenuated virus. Later experiments showed that a safer virus could be prepared by drying over caustic potash at 21 deg. C. spinal cords of rabbits dead of rabies.

By injecting subcutaneously first a weak virus and subsequently a stronger one into parts with very few nervous structures Pasteur succeeded in immunizing dogs against otherwise fatal subdural inoculations. This success suggested the possibility of immunizing human beings. The relatively long duration of the period of incubation, which is commonly about forty days, made the outlook for human immunization peculiarly promising. The opportunity for trying the method soon appeared in the person of the little Alsatian lad, Joseph Meister, who came to Paris with fourteen wounds inflicted by a rabid dog. Pasteur courageously resolved to make an effort to rescue the bitten child from the certain death to which he was doomed, by making successive injections of rabbit viruses of increasing strength. The result is known to all the world; the effort to utilize the long period of incubation to quickly establish immunity through repeated inoculations, proved a success, not only in the case of little Meister, but in many thousand other instances.

The great research on rabies fittingly marks the culmination of Pasteur's long career as an investigator. In that investigation can be seen the same technical skill, the same respect for minute detail and the same pertinacity that had distinguished so many earlier researches, but there can be seen also a degree of originality and a fertility of resource that excel nearly all previous exhibitions of these powers. The accumulated experience of a quarter century of original study of micro-organic life served as intellectual capital on which Pasteur drew for guidance at every turn in the extraordinarily intricate and perplexing study of rabies. And it seems wholly clear that this new discovery could never have been made without such a treasure of experimental experience.

One who looks only at the results of Pasteur's far-reaching work is apt to overlook his mistakes and shortcomings and to forget that he made some serious errors not only in the interpretation of experimental data but sometimes also in experimental technic. To pathologists of the present day Pasteur's conception of acquired immunity appears so crude that it is difficult to believe he ever entertained it seriously. His work on chicken cholera naturally led him to form a theory to account for the immunization which he observed, and this theory was that immunity arises from the inability of a pathogenic organism to grow in a medium in which it has previously developed. Animals thus become immune because the necessary nutrient material for the multiplication of the specific organisms has been made up, just as an organism will after a time cease to grow *in vitro* in an old culture medium. It seems strange that he did not test this theory by trying to grow the organisms outside the body in the blood and serum of both the immunized and normal animals and so learn that he was in error. The short and usually inadequate descriptions of micro-organisms which Pasteur has given in his terse publication have aroused much criticism from bacteriologists and it cannot be denied that he underrated the importance of minute morphological and cultural studies, studies without which some of the most important modern advances could not have been made. Nor is it easy to explain the reluctance with which he adopted the improved bacteriological technic of other investigators. Koch's method of plating bacteria, Weigert's and Ehrlich's methods of staining and certain important nutrient media found their way into his laboratory only after long delay and through the efforts of assistants. Pasteur's comparatively faulty technic for obtaining pure cultures of bacteria is doubtless responsible for many of the disheartening results reported by foreign observers who used his vaccines. Nevertheless his methods in the main served their purpose well, and we should remember that the most finished instruments cannot belong to the pioneer who makes his own tools. Fortunately, Pasteur was greatly favored by the circumstance that in many of his etiological studies he made cultures from the blood, where the specific micro-organisms often existed in pure culture.

Although even the plainest narrative of Pasteur's individual achievements is proof enough that his work holds a unique position in the history of biological science it is worth while to consider in more general terms what it was that the consummate experimentalist added to the science of medicine. Such a consideration gives us a more just measure of his influence than the most detailed recital of specific investigations. If we would understand the influence of Pasteur on medical science we must recognize that his example as the apostle of an almost untried method of approaching the problems of medicine has been no less enlightened than his actual discoveries. Emerson has said, "Great men exist that there may be greater men." The recent history of medicine in the United States as well as in Europe plainly shows that the seed of example sown by Pasteur has already fallen on receptive soil from which have sprung new combinations of human faculties powerful for the amelioration of human life. Our country has no greater cause for satisfaction than the knowledge that the ideality as well as the methods of Pasteur have inspired a growing circle of original investigators in medical science who labor for the common welfare. Let us hope that this circle will be continually widened, in the future as in the past, by accessions from the students of this University, where the best ideals of work have been so richly nurtured.

Perhaps the most deeply significant feature of Pasteur's contributions to medicine is their direct dependence on the principles of physics and chemistry, the sciences that so often lie at the heart of real advances in biology. Medical men trained along the conventional semi-scholastic lines had often dabbled with these fundamental sciences and sometimes the superficial contact had yielded creditable or even important results. In many instances also truly great advances had come from the labors of men who like Malpighi, Bichat and Johannes Müller were wide awake to the fact that sound medicine must rest on sound biological conceptions.

But despite the activity of numerous gifted medical men of broad scientific sympathies the medical profession at the beginning of Pasteur's career was duly following a well trodden but nearly blind road, in the hopeless struggle to solve the intricate problems of human pathology and physiology by minute observations and experiments confined largely to the most complex representatives of animal life. Then for the first time there appeared in the biological sciences a man profoundly trained in the methods of chemistry and physics and inspired, moreover, with a firm confidence in the applicability of these sciences to the solution of biological and medical problems. Triply armed with a sound method, a lofty imagination and a strong will to serve his country, Louis Pasteur entered the wide arena of medical research, to win there the triumphs that have reconstituted medicine and have secured him an undying fame. Step by step, with rigid logic and unfaltering determination, he passed from the early crystallographic discoveries to the new conception of fermentation and from this to the crucial discoveries relative to etiology and immunity for which the medical sciences had waited so long.

To have fought the long battle of life with unwavering constancy to the loftiest ideals of conduct, toiling incessantly without a thought of selfish gain; to have remained unspoiled by success and unembittered by opposition and adversity; to have won from nature some of her most precious and covert secrets, turning them to use for the mitigation of human suffering—these are proofs of rare qualities of heart and mind. Such full success in life did Louis Pasteur attain, and from the consciousness of good achieved, his noble nature found full reward for all his labor.

Of the children whom Fortune has endowed with splendid gifts, there are few whose lives have affected so profoundly and so beneficently the fate of their fellows, few who have earned in equal degree the gratitude and reverence of all civilized men. Although not many can hope to enrich science with new principles, all of us may gain from Pasteur's life the inspiration to cultivate the best that is in us. Let us keep living in our memories the inspiriting words which the master spoke on the seventieth anniversary of his birthday: "Young men, young men, devote yourselves to those sure and powerful methods of which we as yet know only the first secrets. And, I say to all of you, whatever may be your careers, never permit yourselves to be overcome by degrading and unfruitful skepticism; neither permit the hours of sadness which come upon a nation to discourage you. Live in the serene peace of your laboratories and your libraries. First ask yourselves, what have I done for my education? Then, as you advance in life, what have I done for my country? So that some day that supreme happiness may come to you, the consciousness of having contributed in some manner to the progress and welfare of humanity. But, whether our efforts in life meet with success or failure let us be able to say when we near the great goal, 'I have done what I could.'"

REDUCING THE CANDLE-POWER OF GAS.

ANYTHING which Prof. Lewes has to say regarding the gas business is always of interest, and his testimony before the Royal Commission (England) on coal supplies (reported by the Gas World) is of unusual interest. Speaking of reducing candle-power of gas supplied, he says:

"The present-day tendency is toward a lower illuminating power of gas, and that this lower illuminating power would probably be arrived at by diluting ordinary coal gas with either carbureted or blue water gas. Even should the tendency toward reduction in illuminating power not continue, carbureted water gas would play an important part in lessening the weight of coal annually used in gas manufacture." In illustration of the economy to be effected in coal by the manufacture of carbureted water gas, Prof. Lewes cited the Gas Light and Coke Company and the South Metropolitan Gas Company, and the citation may be put in tabular form, thus:

Year ended June 30, 1902.	Coal used Long tons.	Gas made Millions.	Gas made per long ton of coal Cubic feet.
Gas Light and Coke..	1,829,699	22,571	12,336
South Metropolitan ..	1,183,101	11,976	10,123

In explanation of these figures Prof. Lewes said that the Gas Light and Coke Company made 4,079,499,000 cubic feet of carbureted water gas. "From this," he proceeded, "it will be seen that the gas yield per ton was practically identical for the two companies, but that the Gas Light and Coke Company, by making 18 per cent of their gas from coke, steam, and oil, were able to use 403,652 tons less coal than they otherwise would have had to do to get the same volume. This makes no economy in cost, as the carbureted water gas costs a little more than the coal gas, but it enriches the candle-power of the gas and saves 22 per cent on the coal used. About 40 pounds of coke being used in the generator, and 15 pounds of breeze, it is evident that the amount of salable coke will be reduced." Proceeding to speak of the limit of carbureted water gas, Prof. Lewes said:

The limit of quantity of carbureted water gas which can be added to the coal gas is arrived at from the percentage of carbon monoxide in the mixed gas, which, in my opinion, should not exceed 16 per cent, on account of its poisonous properties. From the recommendations of the committee which lately considered the question of water gas, it seems probable that this will be about the legalized limit, and this would enable 48 per cent of carbureted water gas to be added to the coal gas, which would make the saving in coal much more marked. Should, however, the present tendency to lower illuminating power continue, then, undoubtedly, the most economical method of making low-power illuminating gas is to pass blue water gas through the retorts during the carbonization of the coal. The blue water gas containing 38 per cent of carbon monoxide, as against 28 per cent of carbureted water gas, would limit the admixture of about 34 per cent. If such a process were universally adopted throughout the kingdom, the total economy in gas coal would, approximately, amount to about 4,000,000 tons annually.

My own impression is that the useful minimum candle-power of gas one could go to would be 12 candle-power. And with that, with the aid of a mantle, one could get perfect combustion and illumination. The whole theory of the incandescent mantle has been very little understood; one has always thought that the light which is got from the incandescent mantle is almost entirely dependent upon the calorific value of the gas. I have been making a very large number of experiments lately, and I find, to my great astonishment, that you have got other factors distinctly at work, and that with the reductions in illuminating power you do not get at all a corresponding reduction in the light which your mantle emits, within very wide limits indeed. Very often, where you have an enriched coal gas, with fairly high calorific value, your mantle will give an absolutely worse result than when you are using a poor coal gas, say, of 12 candles, and, in fact, even with blue water gas, you can get results which are very nearly as good as with coal gas. Not burnt in the same quantity, but per cubic foot. There was a series of papers read by some American investigators, published a little while ago, by White, Russel & Travers, in which they proved to their own satisfaction, by a most elaborate series of researches, that you had the candle-power of the mantle directly related to the calorific value of the gas. They found that water gas gave 5 candles per cubic foot. With many ordinary burners that you can get in Germany at the present moment you can get 15 candles per cubic foot with water gas, and with one burner, a little more carefully made than the rest, I have got as high as 19 candles with blue water gas. Water gas has a calorific power of 320 British thermal units, whereas 16-candle coal gas, with which you get no greater illuminating power, has a calorific value of 640 British thermal units; and the fact that you have an incandescent mantle giving so little variation in the lighting power shows that this change in the quality of the coal gas is not a very important factor in tending to the lowering of the candle-power with the mantle.

The cost does not fall in relation to the high candle-power. In calculating the cost on the coal-gas you have to take, first of all, the whole body of gas which is non-luminous; you have the illuminating value of the gas depending only upon some 4 per cent of it, while the really expensive and the really best portion of the coal-gas is the methane, or marsh gas, which it contains. So that you might take the whole body of gas, which would give you something about 8d. per 1,000 cubic feet, and then the candle-power is an increment upon that; I mean to say, many people argue that if you get a 16-candle coal gas at 16d. (of course you do not, but supposing you did), they then might take 1d. off for each candle-power that they get, which would mean that they then got the heating body of the coal gas for nothing. But of course you would sell 12 candle-power gas at less cost per 1,000 cubic feet than you would 16 candle-power gas. Therefore, the saving which is effected by the mantle is not the whole of the difference. I understood you to say (and I thought that was rather new) that with the mantle you could get from water gas as much illuminating power as you got out of the coal gas. Yes; very nearly. Would the gas cost the same? No; blue water gas in the holder made by the Dellwik process would cost you perhaps only 10 cents per 1,000 cubic feet, as compared with 26.3 cents for coal gas in the holder. And then there is some fault attached to it, or some difficulty, is there? The difficulty, of course, with that would be the poisonous properties of the gas. You do not call it adulteration, or enrichment, or admixture. You generally call it nothing; you simply send it out.

One may take it that for the same quantity of light or illuminating power, we may look upon the incandescent mantle as being a great coal saver; not only in regard to the enormously increased light which you get from a foot of gas, but also the general tendency which that has on saving gas. The general tendency is to use more light. The whole tendency of the present day is to get to higher and higher lights, and a very bad tendency it is, too.

Great economy can be effected in the weight of coal used for the purpose of making gas by the mixture of coal and carbureted water gas, although there is not very much economy in cost. They would have less coke to sell as a by-product, but the difference is so small that it makes very little difference indeed on the returnable amount of coal. Of course figures of that character can only be got from the yearly returns of the gas companies. Now, the South Metropolitan Gas Company make no water gas, and they sell 1,232 pounds of coke per long ton of coal carbonized, whereas the Gas Light and Coke Company, which does make water gas, sells, I think it is, 1,209 per ton of coal carbonized. So that you may take it that the difference in the sale is a very small one.

In answer to further questions, Prof. Lewes said he had fixed in his own mind that the permissible proportion of carbon monoxide in any domestic gas supply was 16 per cent, which would limit the proportion of carbureted water gas to about 50 per cent of the coal gas. If the present tendency toward lower illuminating power was continued, the most economical method of producing a low-power gas would be to pass blue water gas through the coal-gas retorts during the process of carbonization. If, taking last year's carbonization, you had had such a process as that made universal, it would have made a saving of about 4,000,000 tons. The immediately following questions had reference to the use of oil as a lighting medium, and the Kitson light was mentioned. By the Kitson light and also by a new cold process which is not yet on the market, you can get 1,000 candles per hour for 2 cents. The use of oil will make progress for illuminating purposes. It is not available for anything except big lights. It will not cut seriously into the coal gas, but electric light has a serious competitor in it.

[Concluded from SUPPLEMENT No. 1485, page 23799.]

PRELIMINARY REPORT ON AN ARCHEOLOGICAL TRIP TO THE WEST INDIES.*

By WALTER FEWKES.

STONE AMULETS.

A CONSIDERABLE number of small stone fetishes or amulets were seen in various localities of Santo Domingo and Porto Rico and a few were purchased by the author for the National Museum. Among the stone fetishes in Santo Domingo may be mentioned those in the collection of Señor Imbert of Puerto Plata, and those in the Nazario collection of Porto Rico. The specimens obtained convey a fair idea of the typical form of these objects.

The Antillean stone amulets are regarded as personal fetishes which were worn on the neck or breast. Early writers speak of the native custom of wearing small stone clan fetishes also on their foreheads when the warriors went into battle.

In the Archbishop's collection there is a twin amulet or fetish representing two individuals united at their edges, the only specimen of its form known to the writer. One of the amulets of this general type, which is made of white stone, is perforated from one side to the other, but most of them have holes at the edges and not through the body.

The finest amulet obtained in Porto Rico is somewhat larger than those from Santo Domingo; it is made of marble, with the legs carved in relief and the virile organ conspicuous. The numerous forms of Santo Domingo stone amulets in the Imbert collection vary in size from an inch upward. There are others of shell which will be described later.†

POTTERY.

Although the prehistoric inhabitants of the West Indies were potters, none of their earthenware is of high order. They excelled in relief decoration, practised surface painting only to a limited extent, and were apparently ignorant of glazing. The clay used in their earthenware was coarse, but in some instances the finished product was polished.

The pottery objects vary in form from the shallow platter to the graceful vase, and include bottle-shaped jars and simple double-handled cooking pots. To one of the latter the soot still adhered when found. The most elaborate of all these vessels are the effigy forms, on which the head and other parts of the body are represented in relief. Marks of the coils of clay by which the vessels were built up may still be seen in several bowls. The surfaces were polished with smoothing stones evidently in much the same manner as among the Pueblo tribes of our Southwest.

One of the exceptional forms of Antillean pottery in the Archbishop's collection from Santo Domingo is a vase (Figs. 5 and 6) with a central prolongation for a neck and two lateral extensions, resembling mammæ, on which decorated nipples appear. The central prolongation appears to have been made separately from the body, and to have been later attached with resin or gum. It is ornamented with eyes, mouth, and other organs in relief. In addition to its rarity in form, this jar is a striking specimen symbolically, the genitals of both sexes being represented in its decoration.

A small flat dish is decorated with a sinuous elevation extending about it, recalling the ornamentation

Side view, height, 10¼ inches.

Top view, width, 10¼ inches.

FIGS. 5 AND 6.—TRIPOINTED VASE FROM SANTO DOMINGO.

FIG. 7.—EFFIGY VASE FROM PORTO RICO. (TWO-THIRDS NATURAL SIZE.)

* From Smithsonian Miscellaneous Publications.

† For a fuller account of these amulets see American Anthropologist (N. S.), vol. 5, October-December, 1903.

f a fragment of pottery described by Mason. The two ottle-shaped vessels, with their necks ornamented in elief and the surfaces decorated with incised figures, re not duplicated in collections of West Indian pot- ery. These were obtained from the Archbishop of anto Domingo.

Among the common objects found in the excavation f caves, village sites, and burial mounds, are many mall, burnt-clay heads, often grotesquely human in hape, with protuberant mouths and eyes, suggesting he heads of monkeys, birds, lizards, and other ani- nals. By some writers and many collectors these eads are supposed to be idols and are called zemis, ut there is good evidence that they are simply relief rnaments from the sides or rims of clay vessels, a erfect one of which, in the form of a shallow bowl, ccurs in the Archbishop's collection.

The boat-shaped effigy vase shown in Fig. 7 has a pro- ection on one end bearing a face, and ridges or ele- ations on the sides representing limbs, while the pper surface is ornamented with incised lines form- g complex figures. This vase is said to have been und in a cave at Aguas Buenas, in the interior of orto Rico, but unfortunately the author could not rchase it.

In the collection owned by Señor Neuman, of Ponce, of these is owned by Señor Desangles of Santo Domingo city; another, in the collection of Señor Cambiaso, also of Santo Domingo, has the sharp stones fastened to the surface of the curved wooden board in geometric designs similar to those on Carib objects.

Clubs.—There are several so-called macanas or aboriginal Antillean clubs in Señor Cambiaso's collection. Although similar implements were undoubtedly used by the Porto Ricans, no specimen has yet been found on that island.

The Smithsonian collection contains a broken ceremonial baton from Santo Domingo, which may be considered under this head. It consists of a shaft of wood, at one end of which is cut an animal figure with a cap shaped like a bird. In general form this cap resembles the stone birds sometimes found in Porto Rico, one of which is owned by Mr. Yunghannis of Bayamon. There is every probability that this baton was used in a way somewhat similar to the staves bearing animal images which were erected by the Indians of Guiana on their burial mounds. A similar custom is described by Gumilla, who mentions the use of like objects in the mortuary ceremonies of the Salivas and other Orinoco tribes.

Stools.—The natives of the West Indies made stools or reclining chairs of wood or stone, to which they size. The head is provided with a canopy, as in similar wooden figures. Evidently the eyes were of shell or gold, remnants of an adhesive pitch with which they were fastened in place being still visible in the sockets. The head is hollow, or has a cavity which communicates exteriorly by a hole in the back. Possibly a tube formerly connected this orifice with a hidden man who uttered responses to the questions of the priest through the medium of the idol; in other words, we may suppose that the image was sometimes used for oracular purposes, as described by Oviedo and Gomara.

Serpent.—One of the most remarkable specimens of West Indian carving is an image of a serpent owned by Señor Eugenio Velasquez of Puerto Plata. It is made of very hard black wood, the smoothly polished surface being decorated with incised geometrical figures. It represents a serpent in a single coil, with head slightly enlarged and tail flattened. The head is well carved and is provided with shallow eye-pits in which stones, shells, or gold nuggets were formerly inserted. The snake-like character of the mouth and nostrils is well represented, but the teeth are indicated only by scratches. On the top of the head is an incised circle and other geometrical figures, and the neck has a collar of incised lines, broken at one point,

FIG. 8.—WOODEN IDOL FROM SANTO DOMINGO.

(Imbert Collection; about one-fourth natural size.)

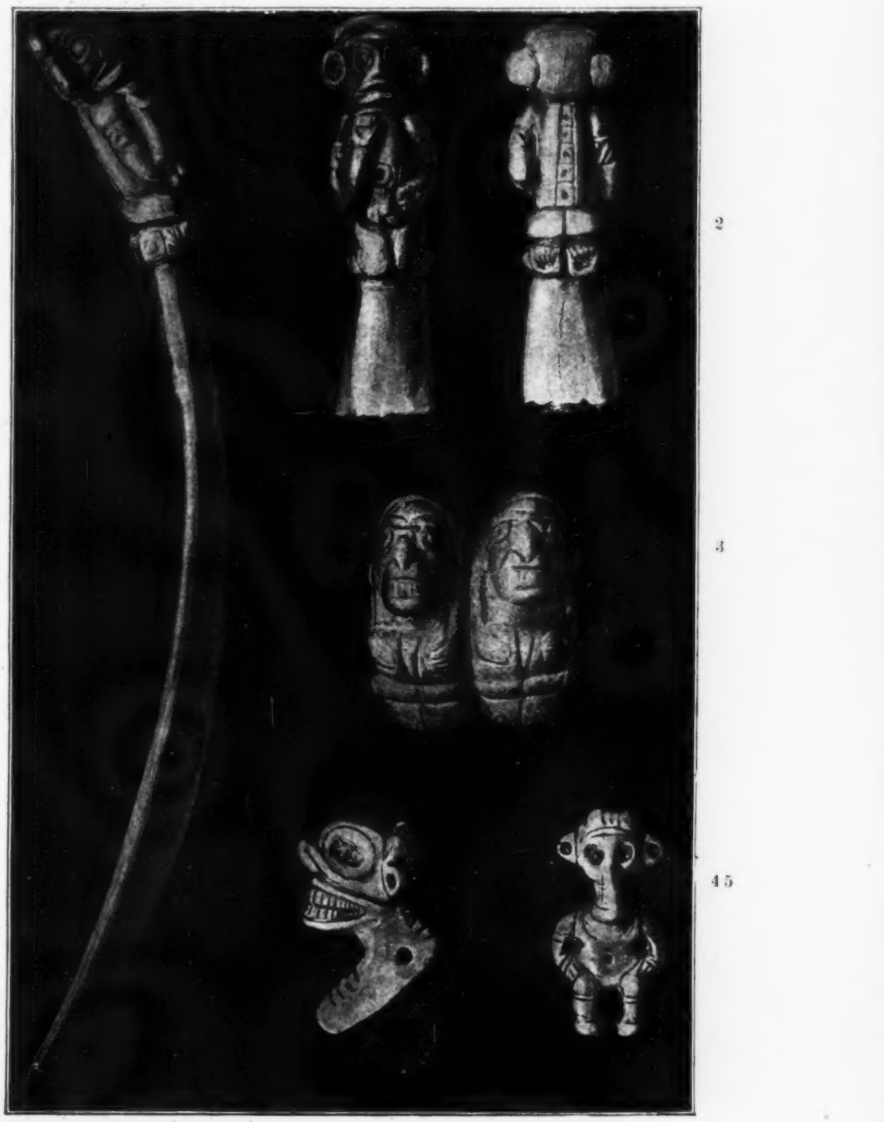


FIG. 9.—CARVED SHELL AND BONE OBJECTS.

1. Regurgitating stick of bone (side view, ¾ natural size). 2. Front and back views of handle (¾ natural size). 3. Twin amulet of shell (¾ natural size). 4. Shell amulet (¾ natural size). 5. Bone amulet (natural size).

re is a globular effigy vase representing a bird, wings, head, and broken tail of which are some- at conventionalized.

A perforated cylindrical roller of terra-cotta, from Archbishop's collection, has its surface cut with elaborate design. It is supposed to be a potter's l and to have been used in transferring patterns the surfaces of earthenware before firing. A cir- ar clay disk, upon which is graven a simple design, y have been used for a similar purpose.

WOOD CARVINGS.

The pre-Columbian West Indians were adept in carv- , and fashioned many implements, idols, and other ects from the hardest varieties of wood. Their ge canoes were manufactured from the trunks of es, and the highly ornamental paddles by which y were propelled are mentioned by several of the ly writers. Cassava-graters, clubs, stools, serpents, ls, and sticks used to induce vomiting are among specimens of carved wood worthy of description.

Cassava-graters.—Flat or curved wooden boards with rp stones so attached as to make a rough surface which to grind the root of the manihot are repre- ted in Santo Domingo collections. One of the best gave the names *turey* and *duho*. These objects were fashioned with great care, sometimes in the form of animals, and often were decorated with much skill. Ten specimens of *duhos** were seen by the author during his visit, five of which were made of wood and five of stone. Eight of the specimens seen were from Porto Rico. One of the two wooden stools especially worthy of mention is in the Imbert collection; the other, which is the best specimen known, belonged to the late Dr. Llenas.

Idol.—Señor Imbert possesses a well preserved idol of human form (Fig. 8), different from any yet described. It is made from a log of hardwood, and was once apparently covered with a black pitch, patches of which still adhere to the surface. The idol assumes a sitting posture, with hands on the knees, below which are enlargements representing the bands with which the Caribs bound their limbs to increase their

* The Jibaros of Porto Rico, especially those in the mountains, still use a wooden stool with goat-skin seat to which they give the name *turey*. Probably the best locality in which to procure these modern stools is near Adjuntas, where lives an old man who is very clever in their manufacture. The ornamentation of the modern *tureys* is limited to inlaid work on the back.

as is common in Antillean circular figures. Along the back of the body there is a row of four circles alternating with triangles and parallel lines, their size diminishing and the ornamentation ending a short distance from the tail, which is flattened and not decorated. On the belly there are well carved, smoothly polished scales. This wooden serpent is probably one of those to which early writers refer, and was no doubt highly venerated by its former owners. The object might also possibly have been used in more modern voodoo rites and ceremonies, but as designs upon it are characteristic of those occurring on prehistoric artifacts from the island, there is every likelihood of its ancient character.

Regurgitating Sticks.—In describing Antillean ceremonies, early Spanish writers casually state that, in approaching the idols, the priests were accustomed to thrust sticks down their throats to induce vomiting, in order that their bodies might be purified before certain rites were performed. This custom, which occurs also in other primitive regions, is mentioned by Gomara, Benzoni, and others, and is illustrated in several early works; the known descriptions and figures of these regurgitating sticks, however, are not detailed

enough to convey an idea of their form. In Señor Imbert's collection there are five wooden sticks, consisting of decorated shafts with handles, which were found with the wooden idol already mentioned, hence are believed to have been used in the regurgitation rite. Their shafts are slightly curved, and are flattened and smoothly rounded at their edges, so that they bear a general resemblance to curved paper-knives.

One of the sticks has the handle carved in the form of a kneeling figure, with globular head and with eyes represented by sunken pits in which, the finder claimed, there were nuggets of gold when he obtained the specimen. The fore-legs of the figure, as is customary in such carvings, are placed close to the side of the head. The part of the shaft just below the handle is decorated with incised grooves, ferrules and other designs.

Another specimen, more elaborate than the first, has a handle carved into an image, the ribs and backbone of which are well indicated. The arms are represented in front of the body, and each hand carries an object different from the other. The feet are more like bird-claws, but the legs have incised lines representing the bands or garters with which the Caribs are said to have girt their limbs to increase the size of their calves. The shaft just below the handle is ferruled, and the incised lines at this point show a break, called the "life line," such as occurs in pottery decorations, idols, and stone pestles. Another of these sticks has a terminal figure with a perforated elevation at the back of the head. Legs are absent, but the arms are well made and are flexed at the elbows, bringing the hands to the chest while the fingers are turned to the palms. This specimen also has the broken incised lines on the shaft.

In the other two specimens of these regurgitating sticks there are slight variations in the arrangement of the limbs of the figure forming the handles, otherwise they are generally similar to those described.

SHELL AND BONE CARVINGS.

Antillean shell and bone carvings are practically unrepresented in the museums of the United States, and little is known of the skill of the aborigines of the West Indies in work of this kind. It is therefore with gratification that the author is enabled to mention a few specimens of shell and bone carving which he was fortunate enough to obtain. The best specimens of this sort that were seen are in the Archbishop's collection from Santo Domingo.

One of the finest examples of shell carving [Fig. 9(4)] is made of the lip of a conch and was apparently used as an amulet. It consists of a head mounted on a base which is perforated for suspension from the neck or forehead. Great care was given to the carving of both the head and the base, the decoration consisting of cross-hatching and circles. The head is generally globular in form; the eye-sockets are depressions or pits in which gold balls were formerly inserted; while the ears, which are cut in relief, also have pits on the side as if to contain similar ornaments. The technique of the mouth and the teeth is good. The end of the nose is slightly upturned; the back of the head bears incised lines arranged in geometric patterns, following the Caribbean style of decoration.

Another carved amulet, of bone [Fig. 9(5)], represents a seated figure with arms akimbo, the hands resting on the knees. Eyes, ears, and appendages to the top of the head are well cut, but the nose is lacking. That part of the figurine which from the front appears to be the neck, is in reality a mouth having rows of teeth, just back of which the object is perforated as if for the passage of a cord by which it was suspended. The details of body and limbs are well worked out, even the umbilicus and leg bands being represented. The general form of this image suggests an amulet for suspension from the body, or perhaps tied to the forehead, a custom which the Caribs are reputed to have observed when they went into battle.

In the Imbert collection there is a flat, rectangular shell plate, about twice as long as broad, perforated at each end. One face of the disk is smooth, but the opposite is decorated with incised circles, dots, triangles, and other figures.

Shell celts, although common in the Lesser Antilles, were not found by the author in Porto Rico; a few, however, exist in local collections, including one owned by Mr. Junghannis of Bayamon, which is almost identical with those from Barbadoes. These objects are generally made from the lip of a more or less fossilized conch.

Apparently several genera of living marine shells were highly prized by the prehistoric Antilleans, for tinklers or bells, for beads, etc., and many genera of marine mollusca have been found in graves and caves in the mountain regions of the island.

The finest specimen of bone carving [Fig. 9 (1, 2)], one of the treasures of the Archbishop's collection, was made apparently from the rib of the manati, or sea-cow. It consists of a curved shaft, flat on one side and slightly rounded on the other, and a handle skillfully fashioned into a kneeling figure with a flattened crowned head. The ears are two prominent extensions, with roughened pits or depressions, as if for the insertion of fragments of shell or gold nuggets. The position of the eyes is indicated by shallow pits, about the margins of which are concentric rings. The mouth is incised, but is without teeth. The body is smoothly polished; the umbilicus and male genitals are represented, and the waist is surrounded by a band. The vertebræ appear as a row of five shallow, incised rectangles along the middle dorsal line. The arms and legs are well cut; one hand rests on the knee, the other on the chest. The toes are shown on the dorsal side of the image, the soles of the two feet being turned in that direction. The incised lines about the legs and arms represent the bandages with which the Antilleans are said to have bound their limbs. There is a small knob on the other side of the ankle. A portion of the handle, as well as of the shaft, is stained green, probably caused by its burial in the guano of the cave in which it was found. The author believes this carved rib was used for the same purpose as the wooden regurgitation sticks above described.

In the Nazario collection there is a clavicle with a carved figure forming the handle. This object was also probably used by the priests to induce vomiting.

PICTOGRAPHS.

There are many rock etchings or pictographs in Porto Rico, particularly on the walls of caves, but as a rule they are more or less obscured by stalagma or vegetable growth. The best preserved examples of picture-writing occur on large bowlders near waterfalls or rapids, or along the banks of the rivers, since the rocks on which they are here cut are not so easily eroded as the softer formations which form the walls of caves.

The author devoted special study to the pictographs near Utuado, at other points along the Rio Grande de Arecibo, and in the caves near Manati, especially in the Cave of the Swallows, previously referred to. These pictographs are usually circular figures representing faces or heads with prominent ears, and sometimes with horns. When, as sometimes happens, bodies are represented, the limbs are appressed to the sides. No animal pictures are to be seen, unless certain zigzag figures may be interpreted to represent snakes. But geometrical figures, as spirals, circles, triangles, and rectangles, are not uncommon.*

* For a fuller account see "Prehistoric Porto Rico Pictographs," American Anthropologist (N. S.), vol. 5, July-September, 1903.

SCIENCE NOTES.

The restoration of the famous Stadion, or Stadium, of Athens, which was commenced in 1895, with funds donated by a Greek merchant, has progressed until they are now placing the last 52,000 marble seats which the great amphitheater contains. The seats, railings, etc., are all of the creamy-white Pentelikon marble, taken from one of the famous quarries in the Pentelikon Mountain in the upper part of this valley. It is the intention of the committee having the restoration in charge to build a marble "propylæa," or entrance, resembling the ancient one. Some urge the finishing of the outer walls of the Stadium by surmounting them with a marble colonnade. When the propylæa will be commenced is not known.

A complete solution of the mysterious strength of desert plants will prove of great economic value to the United States aside from the important information it will give regarding the fundamental processes of protoplasm. In former times bands of roaming Indians inhabited the desert regions of the Southwest. They lived in comparative abundance, and yet the country was no less arid than it is to-day. Doubtless they obtained food from desert plants just as easily as the Papago Indian obtains drinking water from the barrel cactus. White men can do likewise as soon as they understand these plants, and will find many practical uses for the cactus and yucca. An understanding of the source of strength of desert plants will also enable the farmer who irrigates his semi-arid land to judge how much water to apply and how often in order to gain the best results. It will also help him to develop alkali and drouth-resistant types and thus to reclaim new areas.—National Geographic Magazine, Washington, D. C.

For the purpose of insuring pure food for the people of this country Secretary Wilson has established a microscopic laboratory in connection with the chemical division of the Department of Agriculture. Already it has been demonstrated that unscrupulous dealers are palming off artificial coffee and other impure food on the public. The supposed coffee berries were regularly shaped and colored, but were composed of chicory, starch and other ingredients, and when ground presented about the usual appearance of coffee. Cocoa has come in for some curious results under the microscope, and in fact there is now no branch of the Department of Agriculture where this instrument does not play an important part. A large photo-microscopic camera occupies one side of a large room, and is so arranged that foods under inspection may be photographed and the picture thrown upon a screen in the natural colors—a thing of inestimable value to students of grain and vegetable disease. A microtome for cutting up articles for investigation, such as fruit, vegetables and grain, to the two hundred and twenty-five thousandth part of an inch, is one of the new equipments. Arrangements are made for photographing these minute wafers while under the microscope, and from the enlarged sections are made transparencies for throwing upon the screen. A test was made recently of spruce and linen pulp for the manufacture of paper in this country, and it was found the manufacturers were being imposed upon by the importers, and through the determination of the microscopist thousands of dollars were saved. In importing sumac into this country fraud was constantly practised on dealers and manufacturers. This was stopped through this department. This apparatus is also used for getting at the disease of wheat and other grain, and also the adaptability of certain varieties of wheat to different climates, besides ascertaining the amount of starch and other nutritive qualities developed under certain soil and climatic conditions.

TRADE NOTES AND RECIPES.

Perfumes for Toilet Soaps.—(1) Lavender oil, 4; caraway oil, 4; cassia oil, 2; clove oil, 2; fennel oil, 1; Japanese peppermint oil, 1. (2) Lemon grass oil, 6; citronella oil, 4; clove oil, 2; cassia oil, 1. (3) Clove oil, 10; patchouli oil, 5; citronella oil, 5; peppermint oil, 1; cassia oil, 5; artificial bitter almond oil, 2.5. (4) Artificial bitter almond oil, 175; lavender oil, 15; petit-grain oil, 30; bergamot oil, 50; palmarosa oil, 35; coumarin, 10; heliotropin, 3. (5) Citronella oil, 10; anise oil, 2; sassafras oil, 3; cassia oil, 1; clove oil, 1; peppermint oil, 2. (6) Lemon oil, 100; patchouli oil, 5; lavender oil, 20; bergamot oil, 30; clove oil, 80; coumarin, 5; ginger grass oil, 10; cassia oil, 20. (7) Cassia oil, 48; lavender oil, 52; lemon oil, 28; coumarin, 25; ginger grass oil, 25; white thyme oil, 10; caraway oil, 10.—Seifensieder Zeit.

To Give a Black Color to Brass or Bronze Articles.—To provide such articles with a shiny gray or black coating, use is made of the property possessed by certain metallic salts of forming gray or black compounds with sulphur. The article is first plunged into a highly-diluted solution of sugar of lead, if the color is to be gray, or into a solution of blue vitriol, if a black color is desired. When dry the article is placed in a diluted solution of hyposulphite of soda, which should be hot. In a short time either gray sulphide of lead or bluish-black protosulphide of lead will be formed. If the solutions have been sufficiently diluted, the object will present a peculiar iridescent appearance, like that shown by soap bubbles, and due to the same causes. For it is a well-known physical fact that certain substances in extremely thin layers display the phenomenon of color known by the name of iridescence, and sulphide of lead and protosulphide of copper are among the substances possessing this property. If the process described is repeated in extremely diluted solutions, this iridescence passes over into a red, brownish, or violet color. It is impossible to give absolutely definite directions for the production of these colors; success will depend entirely upon the skill of the operator.—Der Metallarbeiter.

Hard-Soldering Fluid.—The composition known by this name consists of a solution of phosphoric acid in alcohol. It is prepared by dissolving phosphorus in nitric acid, evaporating the solution to eliminate the excess of nitric acid, and mixing the syrup mass with an equal quantity of strong alcohol. The phosphoric acid dissolves the layer of oxide; the compound thus formed is melted by means of the soldering bolt, and forced out by the melted solder coming in contact with the metal surface, now thoroughly cleaned. The hard-soldering fluid may be used for soldering copper as well as for soldering brass, bronze, or German silver. Phosphate of ammonia and phosphate of soda can also be used for soldering copper. A useful flux for hard-soldering may be made by mixing quartz sand with pounded soda. The quartz sand consists of silicic acid; the soda, of carbonate of soda. When these two substances are mixed and then heated to a powerful cherry-red heat, they combine to form silicate of soda, and this compound will dissolve oxides if silicic acid is present in excess. With very high temperatures, such, e. g., as are necessary for welding wrought iron, pure quartz sand is sufficient. If it is sprinkled on the glowing iron, and the second portion of iron, likewise in a glowing condition, laid upon the first, both portions being then joined by means of vigorous hammering, the compound of the silicic acid with the iron oxides collecting on the surfaces of the metals will be pressed out in a liquid form, and the iron surfaces, now thoroughly cleaned, will readily unite.—Der Metallarbeiter.

Labels and Labeling.—George W. Hague, Long Island, contributes a few notes on how to use labels to the Druggists' Circular. To paste labels on pill boxes he finds it best to apply the adhesive to the box rather than to the label. Before labeling a tin box he scratches the box and rubs a few drops of compound tincture of benzoin on it. A wet rag laid over an old label to be removed seems to loosen it quicker than soaking it in water.

Label the article with the name by which it is called for, when there is such a name and it would not be really misleading. For instance, many housewives have a decided preference for *essence* of lemon over *extract* of lemon, or *vice versa*.

Mr. Hague does not like hand-written labels and says gummed labels are not worth the space they occupy—that is, in most climates. Neither does he have a very high opinion of numbering machines for use on prescription labels.

Do not keep the paste jar full; a little paste in the bottom is more easily worked with the brush and does not dry out before it is used.

Labels that are stored away should be wrapped in paper and not tied with a string or held together with a rubber band, as the latter cut, tear or indent the labels.

For a surface on which to lay the label before applying the paste, Mr. Hague uses a clean cigar-box lid. He has about five of these, and after using one side of the first one turns it over; after using the other side he places that lid at the bottom of the lot and proceeds in like manner with the other four. By the time the first one has worked its way to the top again, it is dry.

The lids may be washed from time to time as the accretion of paste becomes objectionable.

In making almost any kind of paste, Mr. Hague finds that he gets better results when he replaces half of the water directed by the formula, with extract of witch hazel.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Opportunities for American Merchants in Manchuria.—Introduction.—The building of the great Siberian Railway has helped to open up a new world to the merchants and manufacturers of the West. Lands which hitherto it took three, four, five, and six months to reach may now be entered in the short period of thirty days. The whole western world is intensely interested in every effort being made to open Manchuria, eastern Siberia, and the vast provinces of Asia to the merchants and manufacturers of the West. The economic and industrial papers of Europe teem with reports and articles concerning the opportunities offered by these vast lands to different people of Europe.

The Russian-German Messenger, Der Russisch Deutsche Bote, published in Russian and German, devotes many pages to the consideration of the economic problems of Siberia, Manchuria, and Asia. From an article written by Ferdinand Meinecke, for four years a merchant in Siberia, many of the following notes have been extracted. Among other things he says that the principal business in eastern Siberia is in the hands of some Russian and German wholesale houses. They have covered all the important places of Siberia and Manchuria with retail branches carrying all classes of goods. The exchange of goods for goods instead of for money has not been entirely eradicated in some wild regions of the Far East. Skins of tigers, bears, and sables are exchanged both for commodities and for money.

Dangers of Delay.—The evil connected with all the Russian trade and one to be avoided by western merchants seeking an entrance into this market is the delay in delivery after orders have been secured. Cheap freight rates along the rivers are only possible during the summer months, inasmuch as the rivers are frozen over during the remainder of the year. The result of delays is that goods are often delivered at a time when the rivers are icebound and when it is impossible to forward them by the cheap water freight rates, in which case it is necessary for the wares to remain useless in the warehouses. Since the building of the railroad, however, goods, of course, can be forwarded by rail, but at much greater cost. Cities like Vladivostock and Chabarowsk and cities in Manchuria can, when necessary, get their goods shipped by rail. In spite of this fact most of the firms in the East prefer to have goods come to them by sea and river transportation, since it is cheaper and because the railroad in many cases is somewhat uncertain; in addition, many wares in shipment are broken or stolen, and all complaints for damages are, as a rule, disregarded. Great efforts are being made by the local authorities in the Far East to get better connections for their cities with the western traffic. As soon as these connections are made, vast regions, with immense natural and mineral resources, will be opened to the western world.

Planting Colonists.—In order to get the most out of these regions it will be necessary to encourage the immigration of miners and farmers. It is reported that the Russian government is about to put at least 1,000,000 of its European farmers into that far eastern section. After this is done there can be no doubt of the vast extent the commercial and industrial relations in those parts will assume.

Influence of Tariff.—The importing business of eastern Siberia was materially affected by the introduction of the protective tariff, which is so high that business men have found it impossible to import many foreign articles. It is easy to understand that the Russian government has put this tariff in operation for the protection of its own industries, although one can hardly say much concerning home industries in eastern Siberia up to the present time. Besides, it is a well-known fact that the industries of European Russia are hardly in a position to supply many of the articles needed in a new country like Manchuria and eastern Siberia. Hence, the merchant in the Far East will have to rely upon European and American manufacturers to satisfy the necessities of his client. Exporters will make every effort for prompt deliveries and always up to sample in order to hold old customers and for the purpose of securing new. The writer from whom these notes are being taken liberally says that Germany's greatest competitor in the East and in East Siberia is the American; and to keep step with the American for any length of time will be a very difficult task. Above all things, Germany, he says, must work to secure the success which in the last ten years it has won in the East against the English. A new working field for the German export trade is offered at Port Arthur and at Dalny. Both of these places were for a long time free trading places, but quite recently were placed under a protective tariff. As Port Arthur is almost exclusively a naval port, the situation of Dalny, it seems, will cause the bulk of exports and imports to go through it. Thus Dalny, in spite of its recent coming into existence, has already become an important business city and seems to have a greater future in store, since the trade with all Manchuria will go in and out of its gates.

Lingual Difficulties.—One great difficulty for foreigners in eastern Siberia is the Russian language. Russians do all in their power to make themselves understood when questions of trade are involved. People in commercial and industrial circles do all they can to make the life of foreigners as pleasant as possible. In general, clever young Germans are engaged in the mercantile business in Siberia and Manchuria at wages which afford them little more than a bare living, all the necessities being very expensive. One who expects a position in that far country can not hope to do very much more than to buy necessities and to learn the language and conditions under which trade is carried on. Everybody going there should make it a point to be well prepared with clothing and other necessary equipment for the undertaking in which he is to engage.

In the cities along the border lines between Russia and China the Chinese element is largely predominant. These people are welcome in the cities because of their willingness to work, their peaceful disposition and their desire to live and to work and to be let alone. They are industrious, tireless in their efforts, and far superior to most others.

Goods Wanted.—The best lines of goods to send into eastern Siberia and Manchuria are various agricultural and industrial machinery, tools, woolen cloths of all kinds, cotton cloths to a certain extent, hardware for the kitchen and for the one thousand and one purposes to which articles of hardware can be put, and some articles of luxury. The largest sale in eastern Siberia will be, of course, for agricultural machinery. The demand for these machines will increase with the development of the agriculture of the country. The writer says, in conclusion, that, according to his own experience, preference is given in eastern Siberia to German machinery for the farm over American machinery because the construction of the German machine is more solid. Whether this is so or not is, of course, another question. Efforts on the part of American manufacturers to enter the field and to demonstrate the superior services to be obtained by their machines will be of great value to the American manufacturers.

Opening for Agricultural Machinery in Russia.—There is a good chance for the American manufacturer to introduce his farming implements and machines into Russian Poland, more especially those machines designed for planting, cultivating, and digging potatoes.

Potatoes are planted in Russia and Russian Poland during the month of April and sometimes as late as May 10.

Two methods are employed: (1) In squares from 20 to 24 inches, the average being 22 inches, which are cultivated in both directions, and (2) in rows of 20 to 24 inches wide and from 12 to 22 inches apart, cultivated in one direction.

Labor being much more difficult to obtain in September and October, the more particular needs of the farmer are machines for digging purposes, as the season for such work is from September 15 to October 15.

The rows are always ridged up and the potatoes are planted about 4 inches deep.

The machines in general use in this locality are of native make, in some of which there could be no competition from the American manufacturer, owing to the low cost of those made here.

One of the machines in use here is an implement for making three furrows, in which potatoes are placed by hand, in distances varying from 12 to 22 inches. The distance between the furrows is adjustable from 20 to 24 inches and the depth of same from 3 to 8 inches. This implement is of native manufacture, weighs about 160 pounds, and is drawn by two horses. It sells at retail here for 22 rubles ($11.33).

After the potatoes have been laid in the furrows they are covered and hilled by another implement of native manufacture, drawn by one horse, which retails for from 7 to 10 rubles ($3.61 to $5.15). One-horse hoes are used for cultivating the potatoes.

For some time there have been efforts made by German manufacturers to introduce machinery for planting, cultivating, and digging potatoes, among which was a machine for digging holes. This machine consists of four rows of stars, each having six spades, the distance between the stars and the distance between the spades being adjustable to suit the different requirements of the farmers. In the holes made by these machines potatoes are put by hand, ten people being necessary to do this work. The depth of the hole made is also adjustable to the kind of soil.

The hole-digging machine is followed by a four-row-disk covering machine, which covers the potatoes and ridges them up. This same machine is also found useful as a weed destroyer. It has another advantage in that it well covers potatoes planted on fresh stable manure, without dragging the manure from the ground.

Both machines weigh nearly the same, about 840 pounds, and sell in Germany for the same figure—300 marks (about $71.40).

The diggers used in this country are nearly exclusively of German make and of the "Muenster" pattern (more or less modified).

These potato diggers are far from being perfect, but they are the best known. The plowlike diggers, even of American make, have been frequently tried here, but without success. One of the enterprising Warsaw dealers in machinery tried to introduce American potato diggers into this market, but his efforts were discouraged because the American manufacturer with whom he dealt failed to make the required alterations in his machines or to adapt them to the local method of raising potatoes.

The American manufacturer can not afford to neglect a field which promises so rich a reward for his effort, particularly when one considers that potatoes form almost the sole food of the working classes in Russia and supply also a large part of the income of the farmers who grow them for sale to the distilleries. The present year has been an exceptionally poor one; but the totals from the ten districts of Poland for the years 1899, 1900, 1901—i. e., 6,142,805, 8,391,069, 7,836,269 tons—show conclusively the extent of the industry and furnish a rough estimate of the acreage under cultivation.—Clarence Rice Slocum, Consul at Warsaw, Russia.

Openings for American Mining Machinery in Southern France.—On several occasions I have referred in my annual and special reports to the mining concessions existing in this department, and I have further pointed out the importance thereof in view of the vast progress made in the methods for manufacturing briquettes.

The concessions already existing are those of Carros, Vescagnes, Toudon, and Ascros. These, as heretofore explained, were granted by the government, as is always the case here, only after sufficient work had been done to demonstrate to the satisfaction of the official engineers continuous seams of a thickness and quality that would permit of sound commercial exploitation. Besides these concessions there have been granted at various times "permits to survey," preparatory to the demand for and granting of an ultimate concession.

For the first time in the history of this district a foreign company has taken up the matter. A British incorporated company, duly registered in France, has commenced prospecting at La Mangiarde, near La Tour-sur-Tinee. They are at present operating at a height of 5,412 feet above the level of the sea, where surface seams of very good average quality exist.

The officials of this company claim that up to the present too much importance has been given to the discovery of surface seams, and that a vital error has been made in spending sums of money for tunneling with a view to following up these seams. They claim that the seams in question are mere indications of main bodies existing at lower levels, and they will direct their work at present to extensive borings, reaching, probably, to the level of the sea. They are also about to direct their attention to the concessions already existing with a view to making similar borings. Should their theory be correct (and such a supposition is more than reasonable) the next few years will witness a remarkable development of the mining industry in this district, for there is more than one marked indication of copper and arsenic deposits in the neighborhood of Nice.

In view of these facts, our manufacturers of mining machinery and boring and other appliances should communicate without delay with La Mangiarde (Limited), at La Tour-sur-Tinee, Alpes Maritimes, France.—Harold S. Van Buren, Consul at Nice, France.

American Stores in Manchester.—The time is ripe for the establishment here of stores where United States products of different kinds could be shown by a competent man employed by those exhibiting.

As an example of what I mean, a club of men whose manufactures did not conflict, and who did not feel individually like assuming the whole expense necessary, could be formed, with initiation fees and dues, to pay a man for showing and introducing their goods.

There is already a large colony of Americans here at work, some with a knowledge of the country and its trade, and they might undoubtedly be persuaded to take up other commodities for a proper remuneration.

I will be glad to give the name of an American in the import and export business, with such details of his standing as may be obtainable, to anyone wishing it.—Wm. Harrison Bradley, Consul at Manchester, England.

Electric Smelting of Ores.—Doctor Hannel, superintendent of mines for Canada, who was sent by the Canadian government to Europe in company with other commissioners to ascertain the economic possibilities of electric smelting of ores, has made a preliminary report to the Minister of the Interior in which he pronounces the process both economical and easy and urges its adoption in the Dominion.—W. R. Holloway, Consul-General, Halifax, Nova Scotia.

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Other Reports can be obtained by applying to the Department of Commerce and Labor, Washington, D. C.

BEATING GOLD LEAF.*

By the courtesy of Messrs. A. and E. Tilton, Redbank, N. J., we are enabled to publish some cuts prepared from photographs taken at their works and illustrating the various stages in the process of beating gold leaf. They were also very generous in giving much valuable information regarding this industry, with which many years' experience has made them thoroughly familiar.

The gold is brought to the works in the form of mint bars bearing the United States government stamp; these bars are said to be 998 fine, that is to say, they contain 99.8 per cent of pure gold. Before being subjected to any mechanical treatment, this practically pure metal must be alloyed with a small quantity of silver and copper, to increase its tensile strength to such a degree as to enable it to be rolled and beaten into the extremely fine leaf which is the ultimate product of the process. The proportions of the three metals used are:

12 grains of pure copper.
12 grains of pure silver.
1 ounce of gold 998 fine.

These are melted in the furnace shown in Fig. 1.

The alloy so obtained is worth about $20 an ounce, the pure gold being worth about $21 an ounce.

quartered, giving 840 pieces. The cutting at this stage is effected by means of a fine knife, over which each leaf is folded. The resulting squares are filled into a "shoder" (Fig. 2). This resembles the cutch, but instead of being composed of paper leaves, it is built up of skins.

In it the gold is beaten for about one and a half hours with a 10-pound hammer, until each leaf is about four inches square. The leaves are then again quartered, this time by means of a small instrument called a "sled" or a "wagon," which will be described more in detail below. The quartered leaves are then filled into the "mold," in which they receive their final beating with a 7-pound hammer for three or four hours. This mold is made of a large number of skins precisely similar to the shoder skins, but less worn, the old leaves from the mold being used for the shoder. Coming from the mold the leaves are about five inches square. During the last stages the beating is so directed that the central part of each leaf is thinnest, all the surplus metal being driven toward the edges. From the middle a square 3½ inches wide is then cut out, and this represents the final product, which is "booked," that is to say, packed between the leaves of a little square paper book. This is very delicate work; the gold leaf, now about 1-280,000 inch thick, is excessively sensitive to any mechanical strain, and cannot be handled with the fingers. By blowing on it

time, and therefore two such skins are cemented together, and it is of such double skins that the mold and shoder are composed. One thousand of these double skins make a mold three-quarters of an inch thick.

The skins are made almost exclusively by Messrs. Puckeridge, of London (England), who have for generations produced nearly all the gold beater's skins upon the market. There is a quaint tradition about the history of this firm. In preparing the skins a very delicate varnish is used, which must be of such nature that the gold leaf does not under any circumstances cling to the skin. The composition of this varnish, like many trade receipts in those days, was a family secret. It is related that by some accident one of the girls in the workshop became initiated into the mystery, and in order that it should not become common property, she was induced to marry into the family.

The use of these skins requires certain precautions. They are exceedingly sensitive to changes in the weather, taking up moisture from the atmosphere. If the gold is beaten in over-moist skins, it becomes overheated under the hammer, and the gold leaf is unsound. If, on the other hand, the skins are too dry, the gold does not get sufficiently warm, and it is impossible to beat the leaf thin enough. The second case does not easily occur. The first has to be reckoned

FIG. 1.—THE MELTING FURNACE.

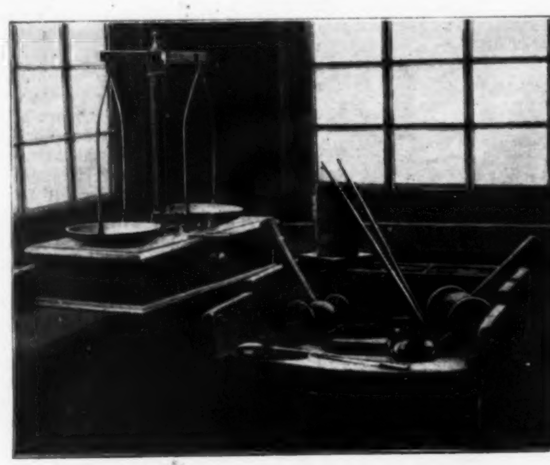

FIG. 3.—VARIOUS TOOLS USED IN THE PROCESS.

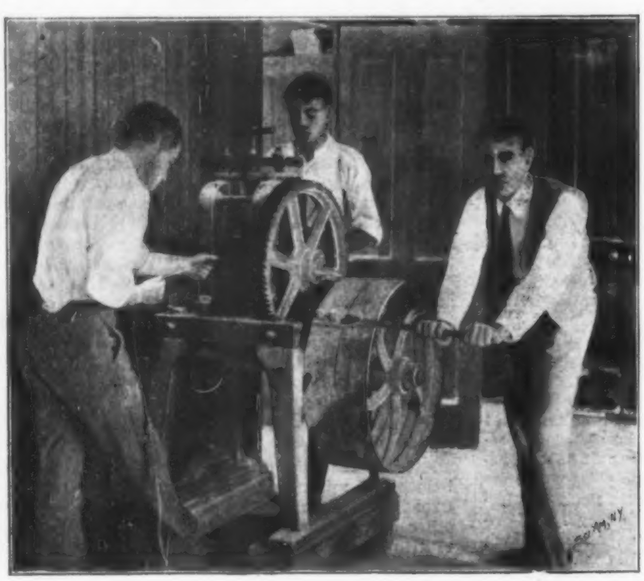

FIG. 4.—ROLLING THE RIBBON.

FIG. 2.—THE SECOND FILLING.

BEATING GOLD LEAF.

The alloy is cast into bars one inch wide, which are then rolled out between rollers of glass-hard steel into a long ribbon having about the thickness of writing paper. This operation is shown in progress in Fig. 4. The ribbon ultimately obtained after repeated rolling is about 24 feet long and weighs about 55 pennyweight. It is cut into 210 pieces of approximately one inch square. These 210 pieces are now worked up together, and constitute one "beating." They are filled into a cutch to receive the first hammering. This cutch is simply a pile of squares 3½ inches wide, cut from a specially prepared tough paper. This paper is made in France expressly for the gold-beating industry. It resembles parchment somewhat, being semi-transparent, but it is more fibrous and of a buff color.

The pieces of gold ribbon one inch square are laid between the leaves of the cutch, which are held together by two parchment bands laid across them, and are hammered for some fifteen or twenty minutes with a 16-pound hammer, until they are of the same size as the leaves of the cutch, 3½ inches wide. A man is seen at this work in Fig. 5. They are then

and lifting it with a wooden forceps, the girls who do this work coax it into its proper place. A girl is seen at this work in Fig. 6; the "wagon" is lying on the table at her right, and she is handling a leaf of gold with the wooden forceps. This completes the process of manufacture of gold leaf, and the little books are sent into the market in "packs," each pack containing twenty books, and about 4 dwt. 6 gr. of fine gold, worth $4.25. The market price of such a pack is about $7.25. As this price is determined only by the number of leaves, and not by their weight, it is in the interest of the gold beater to make them as thin as possible.

Some of the tools used in the process offer points of interest. The industry is a very old one, and the tools used to-day are very much the same as they have been for centuries. This is due in part to the fact that the methods of preparing some of the implements are jealously kept secret. This is particularly true with regard to the manufacture of the gold beater's skins, to which reference was made above, as composing the shoder and the mold. These skins are made from a portion of the intestine of the ox, one animal furnishing no more than two skins. The gut is tightly stretched, and ground very thin. The skin so obtained is too delicate to resist the hammering for any length of

for; every now and again the skins are pressed and dried in a hot press, an instrument shown in Fig. 1, and outwardly resembling a copying press. This drying has to be done more or less frequently, according to the weather. The skins are, in addition to this, brushed over with burnt gypsum before use, the finely-powdered sulphate being passed through a sieve having 120 meshes to the inch, and then applied by means of a hare's foot. A complete mold is worth some $50.

In Fig. 3 a number of the gold beater's tools are shown. There is a chemical balance for weighing the ingredients of the alloy; then two of the hammers, a knife, forceps, and a wagon, also a roll of the gold ribbon and a pile of skins.

The wagons are also shown, rather more in detail, in Fig. 2 and Fig. 6. They are little sledge-like instruments, the part corresponding to the runners forming the cutting edges, and being made of Malacca reed.

Fig. 1 also shows some of the sandware crucibles used in melting the alloy, and the molds in which the bar is cast.

The work requires a good deal of skill, and is said to have a peculiar fascination, though to an outsider the unceasing hammering appears a weary labor.

* Specially prepared for the Scientific American Supplement.

LACE INDUSTRY OF FRANCE.

THE manufacture of laces in France dates back to the days of Louis XIV. In the month of August, 1663, the famous "Declaration du Roy" was published, decreeing the establishment in Arras, Rheims, Sedan, Alençon, Aurillac, and other towns in the kingdom of manufactures of all kinds of thread and needlework, after the manner of the points made at Venice, Genoa, Ragusa, etc. They were to be called "poincts de France" and the decree provided that all such work should be free from duty. In order to encourage the industry in the country, another decree, dated October 12, 1666, forbade any person of any quality or condition to wear, under pain of confiscation of the articles and £1,500 fine, any Venetian or other foreign lace, no matter of what kind. The following year a second decree was issued forbidding the wearing of any dress with silver or gold facings and of lace made outside the country. These decrees also forbade the manufacture or sale of any lace other than that made in the royal manufactories and according to the designs of the directors of the establishments.

Colbert, the minister of Louis XIV., was the chief instigator of these Draconian decrees. He obliged the manufacturers to make only one point or design, to the exclusion of any other. A large number of localities only obtained their living by the kind of lace familiar to them, and everywhere it was believed that the opening of manufactories whence, henceforth, designs were to be issued would cause ruin. But the real aim of the government establishments had not been understood, which was to perfect the industry, in providing models, designs, and methods of execution, constituting precious elements for the improvement of the ordinary manual work.

For twenty years Colbert had to contend with popular prejudice on the subject, but he finally triumphed, for it was through his efforts that the admirable "poinct de France" took rank among the arts and industries of the kingdom.

To-day, in spite of the progress of machine-made lace in the numerous manufactories of the northern and eastern departments, the handmade article holds a respectable rank. The lace makers (women) throughout the country not being organized or syndicated after the manner of other workers, it is difficult to state exactly the number of those who work at the industry, but it does not fall short of 200,000. The wages they receive are in general but small, in proportion to the talent and amount of work furnished. There are places where a clever lace maker will not earn, for twelve or fourteen hours' work, more than 30 cents a day.

In the country around Caen, Bayeux, and Falaise, in the Calvados, where formerly a great deal of lace was manufactured, the inhabitants have decreased by 27,182. In the same department in 1851 there were 50,000 lace makers, while in 1875 they had fallen to 30,000. Yet, in spite of the extraordinary improvement in the machines, the lowering of wages, and the decline of public taste, the handmade industry holds a good many centers.

Alençon still produces its famous point d'aiguille, which enjoys so much favor and employs so many workers (10,000). Handmade lace is found all along the northern coast—Cherbourg, Honfleur, Bolbec, Fécamp, Dieppe, Bayeux, Falaise, and Lisieux. At Honfleur and Dieppe a special kind is manufactured, imitating Valenciennes. But the most active center is at Bayeux, where Chantilly lace is manufactured.

Flanders, the cradle of the lace industry, has lost much of its prestige, while Lille and Arras produce but a small quantity of cheap grades. For Valenciennes, the town celebrated above all others for the lace art, the nimble fingers have ceased to ply the fuseau for nearly a century, although in certain places, such as Bergues, Cassel, Hazebrouck, and Bailleul, an imitation of this fine lace is manufactured.

In the department of Vosges and at Mirecourt a very fine imitation of Brussels point is made, and 20,000 to 25,000 women still work therein.

Lace making is the principal industry of the Haute-Loire. The wives and daughters of the farmers are to be seen everywhere, in the most remote villages as well as in the towns, turning the spindle of the cushion, set on their laps, with surprising agility. As we look on, the web is being formed beneath a forest of pins with glass heads of various colors, which mark the loop of the threads, and the charming design furnished by the manufacturer soon appears.

Lace making in this district is said to have been brought from Italy at the time when the pilgrimage of the Black Virgin of Le Puy was at its greatest activity. At the time when men wore ornaments and finery unknown to our day lace was ardently sought to set off the clothes. In spite of the distance from the great centers of industry, the Haute-Loire took a large place by the side of Flanders and Alençon. This was due, in great part, to the cheapness of the hand work, the natural aptness of the women, the proximity of Lyons, where the fine Holland thread could be procured, and above all to the neighborhood of Beaucaire. The celebrated fair held in this town afforded ready output to the industry, and thence the lace spread over the whole south of France, and even to Spain.

Everyone would have lace—men, women, officers, and grave magistrates, nobles and bourgeois; consequently, Le Puy and its department passed through a period of extraordinary prosperity. This good time was seriously threatened by a foolish edict obtained from the Parliament of Toulouse and sanctioned by the king, which condemned the wearing of any kind of lace or other similar ornament. A Jesuit, however, living in the Haute-Loire, understanding the ruin such an absurd decree would bring to the population, hastened to Toulouse and by considerable effort succeeded in having the edict abrogated. Then he interested the religious orders in the development of the production, and by their missions in South America an important market was opened for lace in that part of the world.

For a long time Spain and her immense possessions constituted one of the principal markets for Le Puy. Those markets lasted until the great commotions at the end of the eighteenth century and the successive wars. This period coincided with the waning of the inventive mind of the manufacturers, and the lace industry, deprived of its best customers, was threatened, by the simplicity of the new fashions, with destruction. The catastrophe would have happened were it not for a manufacturer called Falcon, who endeavored to work against the abandoning of lace making by completely renovating the industry. With natural taste, as well as with a certain amount of practical knowledge, he visited the principal merchants of Lyons and Paris and the museums and private collections. Stored with his experiences, he returned to his native country and immediately began to educate the popular mind in new forms and styles of lace. In a short time the industry once more became prosperous, and to-day, thanks to the ingenuity of the manufacturers and the cheapness of labor, the lace makers of this picturesque department have attained to well-merited fame. For this reason General Gallieni, the governor of Madagascar, recently applied for and obtained a few of the best artisans of the Haute-Loire to introduce lace making into that island, believing that in time the Malgache women may become experts. For this purpose he organized a school where the art is taught to children alone. It is through them that the intelligent governor expects to implant this interesting industry in the colony.

In the Haute-Loire the number of women lace makers is computed at 60,000, while about 30,000 more are scattered through the neighboring departments. It is difficult to give the amount daily earned by these women, as it varies according to the quality of the lace and the section of the country. Some earn only 10 cents a day and none exceed 40 cents, a sum above the average.

The women of the Haute-Loire seem to be born with the talent of lace making and the intelligence necessary to the interpretation of the designs. From an early age the women, of all classes, are familiar with the "fuseau," and the young girls very quickly learn the mysteries of the "entre-deux," as well as the infinite varieties of "passements" indicated on the card of design. This traditional apprenticeship the women of the Haute-Loire rarely forget. Doubtless when they marry they perform the various home duties willingly, but in their hours of leisure they return to the "cushion" to weave some beautiful pattern.

If you want to see the peasant at her favorite work you must go to the "convegi," which in their patois means a meeting or club of women out of doors in summer, and in the "cabinet" or principal room in the house in winter. Rarely is a woman seen working alone. The group, from which cradles are not excluded, affords a curious spectacle in fine weather. Eight or ten women sit round in a circle in the shadow of some house. The youngest have the face framed in a high frill bonnet, covered with lace and tied with a bright ribbon. Their elders have kept up the old custom—a white cap with a very small felt hat, or "tsapelon," fastened on the top by means of a black ribbon.

All of them hold the lace machine ("carreau," a kind of box lower in front than behind and covered with leather and furnished with a cylinder on which to roll the lace as it is made) on their laps. Each cushion has from six to twenty-eight pairs of spools, or spindles. In winter five or six families meet in a house. In the center of the room is a round table supporting a very primitive lamp—sometimes a glass filled with colza oil, in which a wick of raw cotton is steeping. All around stand four or five globes of thin glass filled with water; a ray of strong light is thrown by each of these primitive natural reflectors, permitting the women to work till bedtime.

The picturesque city of Le Puy organized this summer a local exhibition of art in which lace held an important place. The lace exhibition was divided into two sections—ancient and modern. In the former were found very rare specimens lent by Paris houses and private families. Among these I remarked guipure of Venice, Milan lace, point de France Louis XIV., point d'Alençon made for Napoleon I., a magnificent handkerchief of Marie Antoinette, etc.

The modern section was composed almost entirely of the product of this region, consisting of fancy handkerchiefs, corsages, sleeves, collars, cuffs, appliqués for dresses and hats, bed toilets, cushion and pillow covers, curtains, tablecloths, etc.

In another room were exposed a considerable variety of looms, from the humble carreau (cushion) to the most complicated machine representing the latest expression of modern improvement.

A large number of visitors were attracted to this exhibition, and it is believed that this industry, so long vegetating in the Haute-Loire, will receive a considerable impulse from the interest shown in the exhibition.

Before closing this account it must be added that the French government, recognizing the importance for the country of the development of the lace industry, has passed a bill through the Chambers, instituting the professoriate of handmade lace in the public schools of departments where lace is manufactured and also in the normal schools of the same.

Further, special district technical schools for improving the artistic education of the work girls and designers are about to be opened in certain centers.

HILARY S. BRUNOT.

FIG. 5.—BEATING.

FIG. 6.—BOOKING.

BEATING GOLD LEAF.

Dairy Machinery in Russia.—United States Consul-General Richard Guenther, of Frankfort, Germany, under date of April 20, 1904, reports that the Swedish commercial agent at Moscow, in a late report to his government, speaking of the chances for Swedish products in Russian markets, says:

"A large increase in the sale of dairy implements can positively be relied on, especially for separators and other dairy machinery (centrifugals, pasteurizing apparatus, etc.). The Russian government zealously strives to advance this branch of industry and to interest the Russian farmers in dairy production. The exportation of Russian butter has shown considerable and steady gains during the last few years. Of the milk separators now in use by Russian dairies about 80 per cent are of Swedish make. Swedish milk centrifugals are also well introduced."

SELECTED FORMULÆ.

Ink for Marking Polished Metallic Surfaces.—

Rosin	20 parts
Alcohol	150 parts
Borax	35 parts
Methylene blue	1 part
Water	250 parts

Dissolve the rosin in the alcohol and the blue in the solution. Dissolve the borax in the water and mix the solutions. Any other color may be substituted for the blue—for black, nigrosin; for red, eosin, etc. Use sufficient to make the mark plain and legible.—Nat. Druggist.

Essence of Peach-Blossoms.—Cooley gives the following formula for essence of peach-blossoms, "a refreshing and powerful perfume, much esteemed for personal use":

Oil of lemon	1	drachm
Balsam of Peru	15	grains
Oil of almonds	8	grains
Spirit of orange-flowers	2½	ounces
Spirit of jasmine	5	drachms
Alcohol	7	ounces

Agitate them together for a few days, and after another week pour off the clear portion.

Dark Blue Indelible Ruling Ink.—A dark blue ink which is said to resist the action of water, oil, alcohol, oxalic acid, chlorine and alkalies, is made as follows:

Shellac	4 parts
Borax	2 parts
Gum arabic	2 parts
Soft water	40 parts
Indigo, enough to give the desired shade.	

Place the shellac, borax and 36 parts of water in a closed vessel and boil until complete solution has taken place; filter. Dissolve the gum arabic in the remaining 4 parts of water, and mix the two solutions. Boil for five minutes as before, with occasional stirring. When cold, add the indigo in fine powder. Let the mixture stand for a few hours until the coarser powder has subsided, and decant into bottles.—Drug. Circ.

Two Dandelion Root Beer Formulas.—

I.

Tincture of ginger	8 ounces
Oil of wintergreen	2 drachms
Oil of sassafras	1 drachm
Fluid extract of dandelion	1 ounce
Fluid extract of wild cherry	1 ounce
Fluid extract of sarsaparilla	1 ounce
Diluted alcohol, enough to make	1 pint

II.

Dandelion	2 ounces
Burdock root	4 ounces
Sarsaparilla	4 ounces
Sassafras	2 ounces
Caramel	2 drachms
Calamus	4 drachms
Oil of wintergreen	30 minims
Oil of sassafras	30 minims
Diluted alcohol	1 pint
Alcohol	2 ounces
Water, a sufficient quantity.	

Mix the drugs and, if not already powdered, reduce them to a coarse powder, moisten with the diluted alcohol, macerate and pack in the percolator, and percolate with the remainder of the diluted alcohol and then with the water until the drugs are exhausted. Reserve the first 28 ounces; evaporate the weak percolate to 4 ounces and add to the reserved portion. Dissolve the oils in the alcohol, add to the percolate and filter, if necessary, through purified talcum or calcium phosphate.—Drug. Circ.

Colored Fires.—The following formulas for outdoor fires will give products satisfactory as to illuminating effects. All these mixtures are more or less dangerous to make and handle and should be prepared only in small quantities as required for use, and not stored, as some are liable to spontaneous combustion. The salts should be dried and all the ingredients powdered separately and the powder mixed with a wooden spatula:

Red.

Potassium chlorate	10 parts
Strontium nitrate	80 parts
Sulphur	26 parts
Charcoal	6 parts

Green.

Potassium chlorate	4 parts
Sulphur	5 parts
Barium nitrate	14 parts

Yellow.

Potassium nitrate	12 parts
Sulphur	4 parts
Sodium bicarbonate	2 parts

Purple.

Black antimony sulphide	1 part
Copper oxide	3 parts
Sulphur	6 parts
Potassium nitrate	6 parts
Potassium chlorate	12 parts

White.

Black antimony sulphide	1 part
Sulphur	4 parts
Potassium nitrate	12 parts

Blue.

Alum, dried	3 parts
Potassium chlorate	6 parts
Shellac	2 parts
Sulphur	1 part

—Druggists Circular.

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